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PROCEEDINGS
OF
CONFERENCE OF COLLABORATORS
FROM
SOUTHERN AGRICULTURAL EXPERIMENT STATIONS

* * * * *

RESEARCH ON SOUTHERN FOOD CROPS
PROGRESS AND PROSPECTS

held at
New Orleans, Louisiana
March 16 and 17, 1970

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

This Conference was sponsored jointly by the Southern Agricultural Experiment Stations and Southern Utilization Research and Development Division of Agricultural Research Service, U.S. Department of Agriculture. Its purpose was to exchange information related to the research activities of both the Stations and the Division.

In addition to reports by members of the State Agricultural Experiment Stations and our Division, included in this Proceedings are several talks by representatives from industrial firms and other government agencies. These talks deal with marketing, pollution, pests and pesticides, and sanitation in food processing.

These proceedings report in full the statements presented by the various speakers during the conference and give an account of the discussions following.

C. H. Fisher, Director
Southern Utilization Research and Development Division

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Underscored numbers in parentheses refer to references at end of each paper. References, figures, and tables are reproduced essentially as they were supplied by the author of each paper.

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PROCEEDINGS OF CONFERENCE OF COLLABORATORS FROM SOUTHERN AGRICULTURAL EXPERIMENT STATIONS. RESEARCH ON SOUTHERN FOOD CROPS–PROGRESS AND PROSPECTS, HELD AT NEW ORLEANS, LA., MARCH 16 AND 17, 1970

J. A. Whatley, General Chairman,
Oklahoma State University
Stillwater, Okla.

OPENING REMARKS

by

C. H. Fisher, Director
Southern Utilization Research and Development Division
New Orleans, La.

I welcome you warmly to this annual Conference of the Collaborators from the Southern Agricultural Experiment Stations. Particularly because the Deans of Agriculture and Directors of the Southern State Stations have not met in New Orleans for some time, I would like to give a special welcome to those attending this Conference: L. E. Hawkins, Director-at-Large, for the Southern Region; J. Norman Efferson and Doyle Chambers of Louisiana; J. H. Anderson of Mississippi; H. O. Kunkel of Texas; and J. A. Whatley of Oklahoma, our General Chairman.

I wish to give a special welcome also to Julian C. Miller of LSU, who has done so much for agriculture.

We in the Southern Utilization Research and Development Division (SURDD) are pleased to have the privilege of sponsoring these annual Conferences in cooperation with the Southern State Stations. These Conferences, which have been held for three decades, aid research planning, facilitiate cooperation, and in general enhance the productivity of agricultural research. In addition to the research benefits of the Conferences, we derive personal pleasure from meeting with our friends from industry and other units of the States-USDA complex engaged in agricultural research.

During the three-decades that these Conferences have been held and the USDA Utilization Research Divisions have existed, we have seen a revolution in agriculture in the United States and a "green revolution" in agriculture in some developing nations. The revolutionary progress in agriculture was summarized aptly in the 1968 report of Congressman Jamie Whitten's House Committee:

> "It now takes so few of us to produce the food, clothing, and shelter for the rest of us, that the rest of us can provide the highest standard of living ever known for all of us."

Advances in marketing, utilization, and nutrition have also been impressive. These may be illustrated by listing some of the developments stemming from cooperative research in the Southern Region:

Frozen citrus concentrates

Fresh pack cucumber pickles

Instant sweetpotato flakes

Partially defatted peanuts

Edible cottonseed protein concentrate, now manufactured on a pilot-plant scale in India

Orange powder or crystals, which are scheduled to go to the moon on the next Apollo flight.

The first two products–citrus concentrates and fresh pack cucumber pickles–are worth about $400 million annually. The consumer pays nearly $1 million per day for orange concentrate alone.

We invite you to visit our Laboratory on the Lakefront and to discuss research with our scientists. Among other things, these discussions will show that our program has been modified to keep abreast of the changing needs of our Nation. We are giving increasing attention to problems concerned with pollution, health and safety, rural and community development, and increased exports. Examples are listed below:

Pollution projects are:

Air pollution from citrus pulp dryers;

Dry caustic peeling of sweetpotatoes in cooperation with our Western Utilization Research and Development Division;

Pure culture fermentation in making pickles;

Whole fruit purees and drinks;

Freeze or cryogenic peeling of tomatoes;

Recovery of citrus essences and peel oil from processing plants;

Recovery by reverse osmosis of soluble solids (about two-thirds sugars) from citrus processing wastes; and

Modifications in textile processing to reduce pollution.

We feel that progress in this area was greatly aided by a conference held in the Southern Regional Research Laboratory last August. This conference, sponsored jointly with the Louisiana sweetpotato industry, emphasized the handling and disposal of wastes from vegetable processing plants.

Important projects in the health and safety areas are:

Flame-resistant textile products and upholstery to decrease death and injury;

Removal or inactivation of detrimental materials in farm commodities;

Decreased microbiological contamination of textiles during laundering; and

Fire-retardant coatings.

Rural area developments:

All our cotton processing and utilization research; and

The properties and utilization of naval stores from Arizona stumps.

Exports:

Projects on the use of short staple cotton, improved cotton products, whole fruit purees, protein concentrates and isolates, and dehydrated foods.

Our Program Committee, chaired by Doyle Chambers and cochaired by Bruno H. Wojcik, has arranged a spendid program featuring excellent and distinguished speakers and chairmen.

I wish to thank the members of the Program Committee and all others contributing to the Conference, including:

The Directors of the Southern Agricultural Experiment Stations for wise counsel and cooperation in sponsoring the Conference.

General Chairman James A. Whatley, Dean of Agriculture and Director of the Agricultural Experiment Station, Oklahoma.

L. E. Hawkins, J. N. Efferson, and F. R. Senti for special presentations.

Our Session Chairmen, H. O. Kunkel, R. J. Dimler, and J. H. Anderson.

We in the SURDD, and many others, were shocked and greatly saddened by the recent and untimely passing of John J. Mikell. Dr. Mikell, a South Carolinian, received his undergraduate training at Clemson University, majoring in horticulture. Graduate work led to the M.S. degree at LSU and the Ph.D. degree at Cornell University, with emphasis in plant breeding and plant physiology.

Dr. Mikell's professional career started in his home State at the Truck Experiment Station, Charleston, S.C. Following his stay in Charleston, Dr. Mikell joined the Louisiana Agriculture Experiment Station in Baton Rouge. Here he devoted much of his effort to breeding and physiology research on sweetpotatoes, tomatoes, and cabbage.

His former colleagues in Baton Rouge have spoken of Jack Mikell as an untiring worker and one with tremendous patience with all people with whom he worked. He was one who never wanted to see anything go wrong with any of his colleagues. You would never find anyone who did not like and respect Dr. Mikell. His former colleagues were impressed also because he always assumed responsibility for any job given to him and saw it through to the end. The following is a direct quote: "He carried a heavy load. He was the best loved man in the Station. Even the kids at his church, in which he served as an Elder, loved him and sought him out. There seemed to be no problem of a generation gap between him and the kids."

We in this Division were not as closely associated with Jack Mikell as were his former colleagues in Baton Rouge. Nevertheless, we quickly learned to love Jack as a good and true friend. We admired him for his excellent personal qualities and his devotion to agriculture and his fellowman. We are very grateful because we had the benefit of his excellent advice for many years, particularly in planning successful conference programs.

IMPROVED NUTRIENT COMPOSITION OF TRADITIONAL FOODS

by

F. R. Senti, Deputy Administrator
Marketing and Nutrition Research, ARS, USDA
Washington, D. C.

The title of my talk—"Improved Nutrient Composition of Traditional Foods"—very likely raises a few questions which should be tackled at the outset. Why should we consider upgrading the nutrient content of traditional foods—those we consider as staples in American diets—when our food industry is introducing new foods at an ever-increasing pace? Is there a need for improving the nutritive composition of foods in the first place? And if there is a need, in which nutrients? For which persons? Which foods should be modified and how should they be modified; that is, increased in nutrient content?

There are three ways that nutrient levels may be increased which I should like to discuss: Fortification by addition of nutrients, improvement in composition of food crops by genetic selection, and prevention of losses by improved processing methods.

But first let's look at nutrient needs as revealed by findings from dietary surveys such as the nationwide household food consumption survey conducted by the U.S. Department of Agriculture in 1965-66. This was the fifth survey of this type conducted by the USDA since 1936. Thus, we have a series of surveys which enables comparison of diet quality over the years. Also, these surveys provide a measure of the kinds and quantities of foods used in a week by households of different incomes, in cities and rural areas, and in four regions of the country.

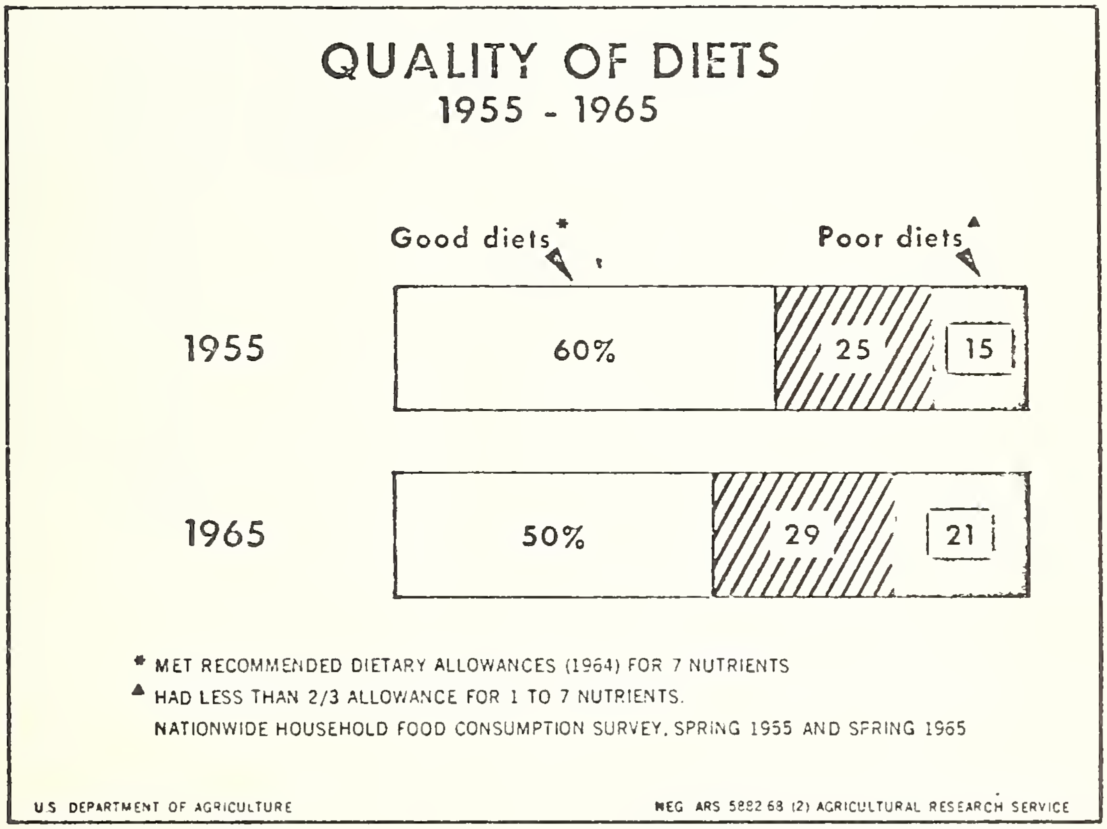


Figure 1.

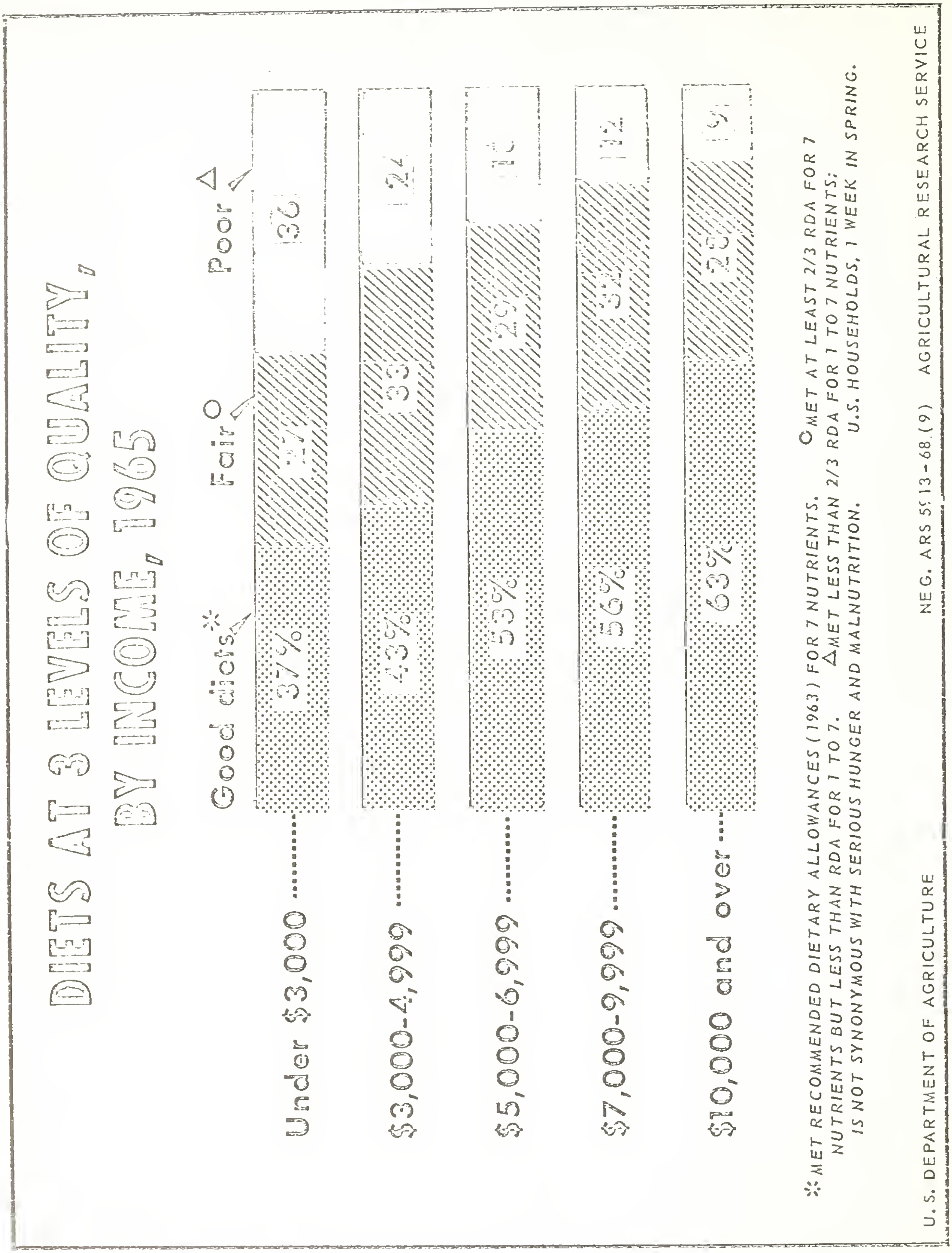

DIETS AT 3 LEVELS OF QUALITY, BY INCOME, 1965
Good diets*
Fair ○
Poor △
Under $3,000
37%
27
36
$3,000-4,999
43%
33
24
$5,000-6,999
53%
29
18
$7,000-9,999
56%
32
12
$10,000 and over
63%
28
9
* MET RECOMMENDED DIETARY ALLOWANCES (1963) FOR 7 NUTRIENTS. ○ MET AT LEAST 2/3 RDA FOR 7 NUTRIENTS BUT LESS THAN RDA FOR 1 TO 7. △ MET LESS THAN 2/3 RDA FOR 1 TO 7 NUTRIENTS; IS NOT SYNONYMOUS WITH SERIOUS HUNGER AND MALNUTRITION.
U.S. HOUSEHOLDS, 1 WEEK IN SPRING.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ARS 5913-68 (9)
AGRICULTURAL RESEARCH SERVICE

Figure 2.

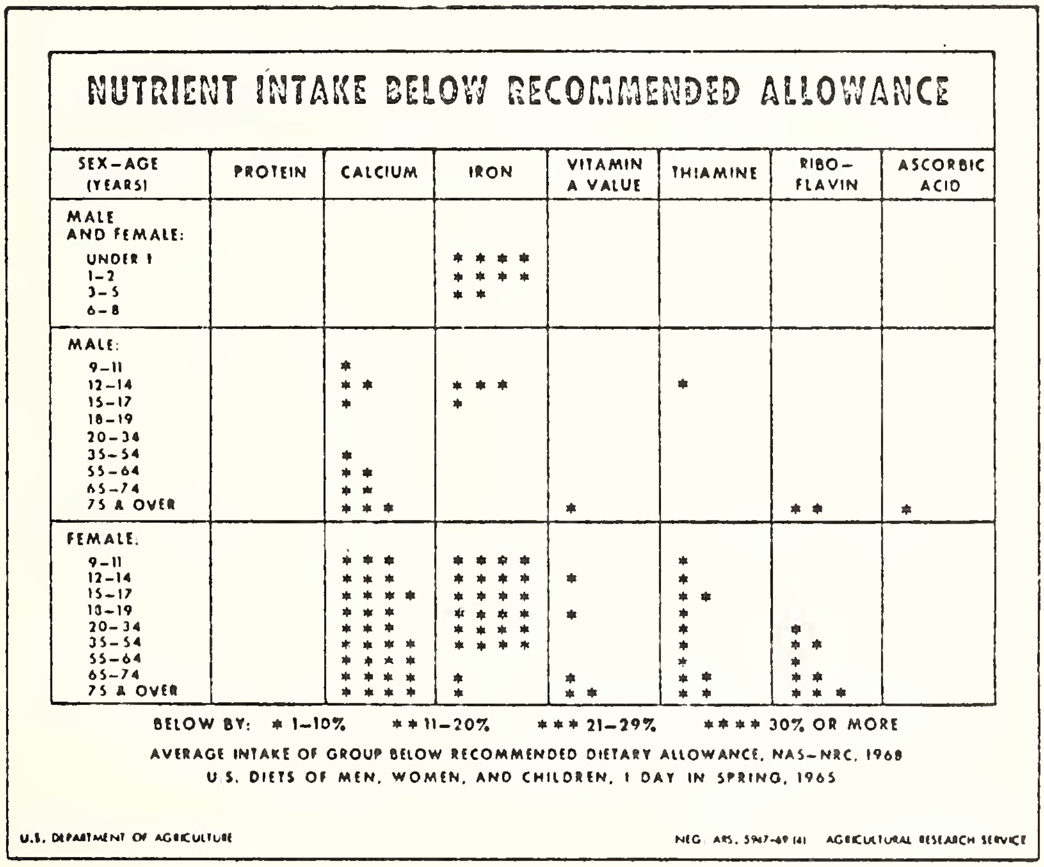
The results of this survey, presented in figure 1, showed that diets of U.S. households were found lower in quality in the Spring 1965 survey than 10 years earlier in the similar survey of 1955. Half of the households had diets rated "good." That is, their food met the recommended allowances for each of seven nutrients at the levels established by the National Research Council, Food and Nutrition Board. But this was a decline from the 60 percent of households with good diets in 1955. At the other end of the scale, 21 percent of the households surveyed in 1965 had diets rated "poor" as compared with only 15 percent a decade earlier. Poor diets were defined as those meeting less than two-thirds of the recommended allowance for at least one or more of the seven nutrients studied.

Low income households had even lower grade diets (fig. 2). Only 37 percent of the households with annual incomes under $3,000 had good diets and 36 percent had poor diets. While there was an improvement in the diets of families at successively higher income levels, you will note that even at the $10,000 and over level, 9 percent, or about one out of 10 households had diets rated poor.

Thus, an adequate food budget is not, in itself, an assurance of a nutritionally adequate diet. These income relationships suggest that an improvement in the nutrient content of foods should help the low income families by providing more nutritive value in their economically limited food purchases. Also, it would upgrade the diets of those higher income households who, for whatever reason, do not appear to choose foods of the kinds and quantities that would provide good diets.

But an evaluation of household diets does not tell the full story as to whose diets need improvement. What is needed is some measure of the allocation of household food supplies among the individual family members. For the first time, in the Spring 1965 survey, we obtained such a measure. Information was obtained on the 1-day food intake of 14,500 men, women, and children. The nutritive value of food eaten, at home and away from home, was calculated in terms of averages for 22 sex-age groups and was compared with the Recommended Dietary Allowances for each group.

Figure 3 summarizes the findings on diet quality for individuals by sex and age. A single



NUTRIENT INTAKE BELOW RECOMMENDED ALLOWANCE

SEX-AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMINE	RIBO-FLAVIN	ASCORBIC ACID
MALE AND FEMALE:							
UNDER 1			* * * *				
1-2			* * * *				
3-5			* *				
6-8							
MALE:							
9-11		*					
12-14		* *	* * *		*		
15-17		*	*				
18-19							
20-34							
35-54		*					
55-64		* *					
65-74		* *					
75 & OVER		* * *		*		* *	*
FEMALE:							
9-11		* * *	* * * *		*		
12-14		* * *	* * * *	*	*		
15-17		* * * *	* * * *		* *		
18-19		* * *	* * * *	*	*		
20-34		* * *	* * * *		*	*	
35-54		* * * *	* * * *		*	* *	
55-64		* * * *			*	*	
65-74		* * * *	*	*	* *	* *	
75 & OVER		* * * *	*	* *	* *	* * *	

BELOW BY: * 1-10% ** 11-20% *** 21-29% **** 30% OR MORE

AVERAGE INTAKE OF GROUP BELOW RECOMMENDED DIETARY ALLOWANCE, NAS-NRC, 1968

U.S. DIETS OF MEN, WOMEN, AND CHILDREN, 1 DAY IN SPRING, 1965

U.S. DEPARTMENT OF AGRICULTURE

NEG. ARS. 5947-69 (4) AGRICULTURAL RESEARCH SERVICE

Figure 3.

star indicates that the average intake for the sex-age group was 1 to 10 percent below the recommended allowance; two stars, 11 to 20 percent below; three stars, 21 to 29 percent below; and four stars, 30 percent or more below. That is, white space indicates average nutrient intakes are above recommended allowances; stars indicate intakes below allowances.

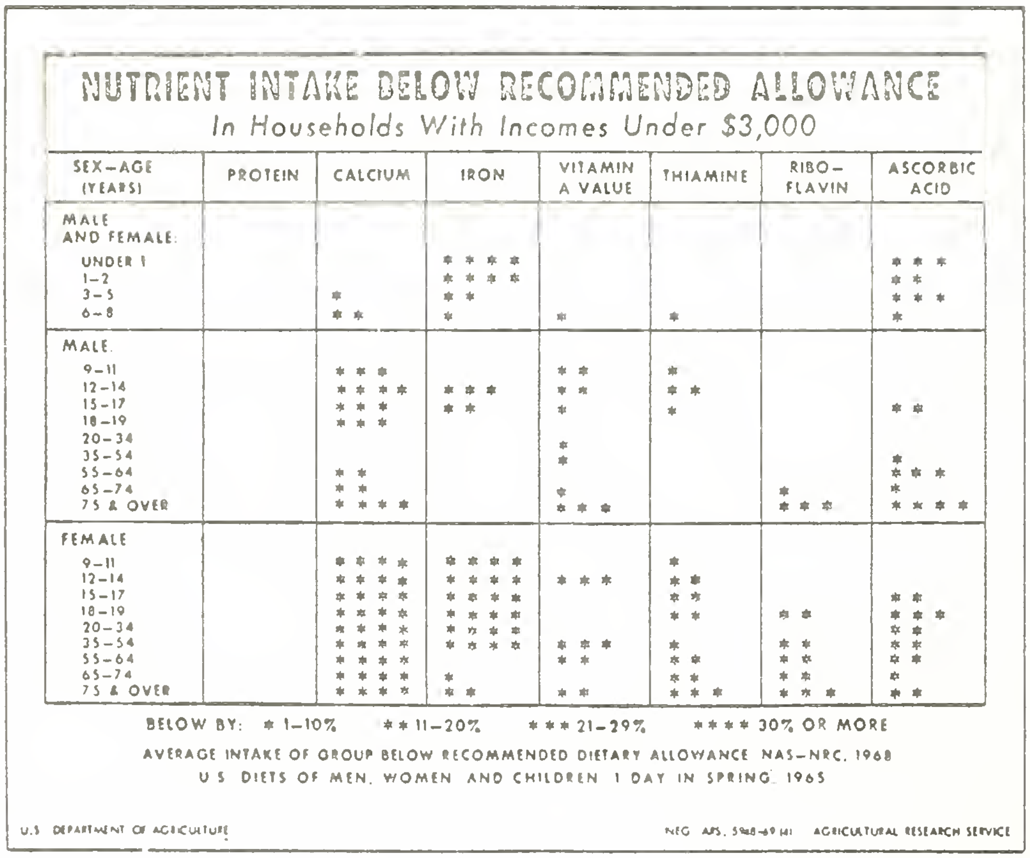
For most of the sex-age groups, average nutrient values of diets approached or were above recommended allowances for protein, vitamin A value, thiamine, riboflavin, and ascorbic acid. But where are the problems? Whose diets need improvement? Calcium and iron were below the allowances for more sex-age groups than any other nutrient, girls over 9 years of age and women reported average calcium intakes far short of allowances. The groups with iron intakes well below allowances were infants and children under 6 years, girls and women, 9 to 55; and boys in the 12 through 14 age group.

These are average nutrient intakes we are talking about. We would expect that intakes for some individuals within each sex-age group would fare better and some worse than the average indicates.

When we look at diets of individuals in only households with incomes under $3,000, as shown in figure 4, the picture is not as good, particularly for calcium, vitamin A, and ascorbic acid. It is significant that individuals in low-income households maintained iron levels about equal to those of all incomes. But far more of the sex-age groups in these low income households were below the allowances for ascorbic acid (vitamin C) and vitamin A value.

In addition to the seven nutrients shown here, we have also made some estimates of the amounts of magnesium and vitamin B_6 and B_{12} in the food intake of individuals, as reported in the 1965 survey. We considered it advisable to do some exploratory analysis, because the Food and Nutrition Board included these three nutrients, for the first time, in their 7th revised edition of the Recommended Dietary Allowances, published in 1968. Our results are preliminary and, in many cases, had to be based on imputed values for those foods for which food composition values for these nutrients were unavailable.

Information on nutritional requirements of these three nutrients is limited. Thus, these RDA's are subject to revision as more data become available and as analytical values are assessed.



NUTRIENT INTAKE BELOW RECOMMENDED ALLOWANCE

In Households With Incomes Under $3,000

SEX-AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMINE	RIBO-FLAVIN	ASCORBIC ACID
MALE AND FEMALE:							
UNDER 1			****				***
1-2			****				**
3-5		*	**				***
6-8		**	*	*	*		*
MALE:							
9-11		***		**	*		
12-14		****	***	**	**		
15-17		***	**	*	*		**
18-19		***					
20-34				*			
35-54				*			*
55-64		**					***
65-74		**		*		*	*
75 & OVER		****		***		***	****
FEMALE							
9-11		****	****		*		
12-14		****	****	***	**		
15-17		****	****		**		**
18-19		****	****		**	**	***
20-34		****	****				**
35-54		****	****	***	*	**	**
55-64		****		**	**	**	**
65-74		****	*		**	**	*
75 & OVER		****	**	**	***	***	**

BELOW BY: * 1-10% ** 11-20% *** 21-29% **** 30% OR MORE

AVERAGE INTAKE OF GROUP BELOW RECOMMENDED DIETARY ALLOWANCE NAS-NRC, 1968

U S DIETS OF MEN, WOMEN AND CHILDREN 1 DAY IN SPRING 1965

U.S. DEPARTMENT OF AGRICULTURE

NEG. ARS. 5948-69 (4) AGRICULTURAL RESEARCH SERVICE

Figure 4.

But, on the basis of current allowances, it appears that all age groups of both males and females over age 8 had diets averaging below the RDA's for magnesium. Diets of girls and women were below the magnesium allowance by a greater extent than males, and diets of older persons, particularly males, did not rate as well for this mineral as those of younger persons.

All age groups of females over 8 years averaged below the RDA's for vitamin B_6, but only the men of ages 55 and older were below to a considerable extent.

Vitamin B_{12} shows up much better in these preliminary calculations. Only the older women, those 65 and over, averaged more than 10 percent below the RDA's for vitamin B_{12}.

In summary, then, we see that many population groups, and not only low income groups, do not get their Recommended Dietary Allowances of several vitamins and minerals.

Let's take a closer look at iron (fig. 5). For whom is needed improvement the greatest? This study and others offer evidence that a large number of girls and women may not be getting sufficient iron from the foods they eat. In addition, there is considerable evidence that many infants and children are not getting enough iron. In the 1965 survey, girls of age 9 and over and women through age 54 averaged just under two-thirds of the RDA for iron, in each of these age groups. Furthermore, infants and children up through 2 years of age met less than one-half of the allowance, on the average. The only males who were significantly below in iron were boys 12 through 14 years. There is increasing evidence of iron deficiency anemia among young children, girls, women, and elderly people. According to preliminary findings from the National Nutrition Survey, being conducted by the Public Health Service, with emphasis on low income groups, one-third of all children under age 6 had unacceptable hemoglobin levels, an indication of anemia.

Overall, for all persons examined in the survey, 15 percent were reported to have low hemoglobin levels.

These dietary and nutritional status studies and other similar studies indicate a need for greater iron intake in the diets of many people. The question is, how can diets be improved for those particular people whose need is greatest?

It is evident that traditional foods as selected by many of our population groups do not furnish the required amount of iron. The magnitude of the deficiency can be seen by noting

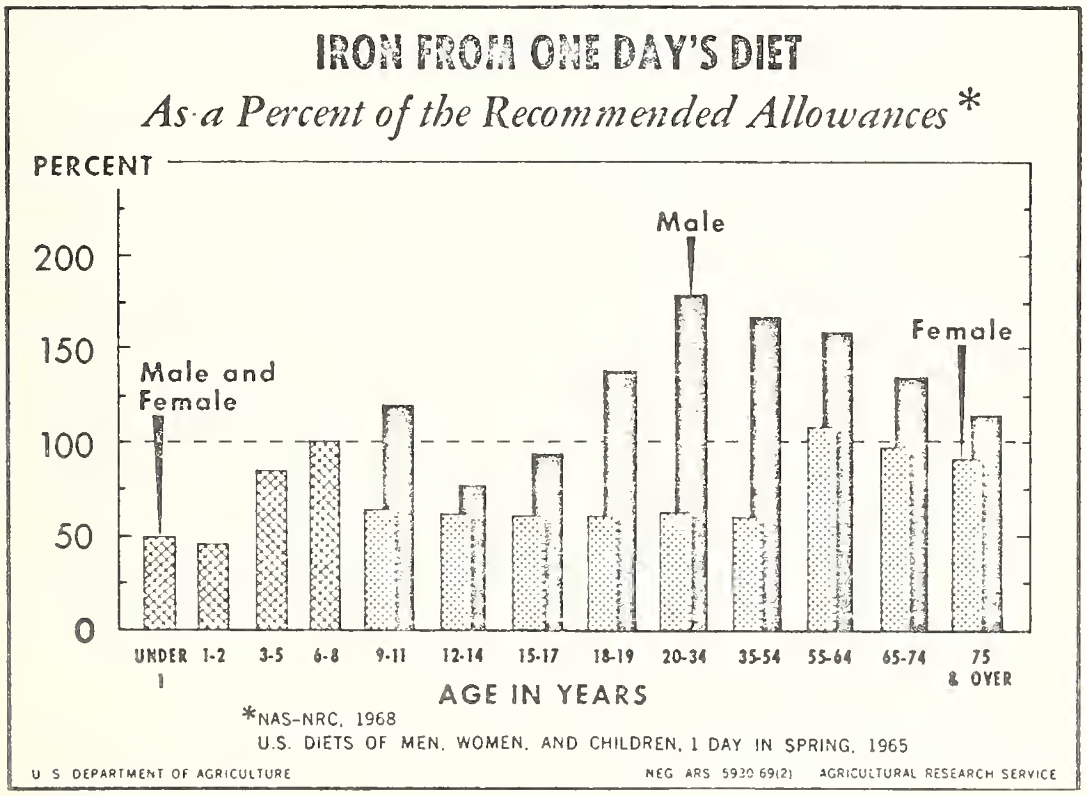


Figure 5.

that females of ages 10 through 55 have a Recommended Dietary Allowance of 18 mg. per day. For a caloric intake of 2,000, this amounts to 9 mg. per 1,000 calories. In contrast, however, normal food selections of these people averaged only between 5.1 and 5.7 mg. iron per 1,000 calories.

A similar situation exists for preschool children and for boys aged 12 to 17–the normal selection of foods contains inadequate iron. Either eating habits would need to be grossly distorted, or the caloric intake greatly increased to meet the iron requirement.

Fortification of traditional foods.–The solution in this case appears to be iron fortification of foods. To accomplish the purpose, foods selected as vehicles for fortification should be widely used and in amounts such that they will provide the required iron at reasonable levels of fortification. Grain products meet the major criteria for a good vehicle for iron fortification. They are included in the diet at all levels of income and in greater quantities in diets at low income levels. They are used by boys and girls and men and women of all ages (fig. 6). They are well-liked, relatively inexpensive, and indeed, many grain products are now enriched. These include flour, bread, cornmeal, grits, and rice for which there are standards of identity for the enriched product.

It is now being proposed that the level of iron fortification in flour and bread be increased about fourfold: From current 13.5 to 16 mg./lb. for flour to 50 to 60 mg./lb. This should help the dietary intake of iron considerably. It would help more, however, if bakery products other than bread, for example, doughnuts, sweet rolls, crackers, cookies, and cake were enriched with iron since consumption of these products is nearly as large as that for bread. Moreover, consumption of these products is increasing whereas that of bread is decreasing. Household consumption of these (other bakery products) products was 67 percent higher in 1965 than in 1955 (table 1).

Fortification of grain products has little impact on the iron intake of the child under 2 years of age (fig. 6) whose dietary intake is also deficient. A vehicle which would reach this group would be iron fortified with milk (fig. 7). Recent work in our Dairy Products Laboratory of our Eastern Utilization Research and Development Division indicates that certain iron compounds can be added to milk without adverse flavor change and with adequate storage stability at a level of 10 mg./quart.

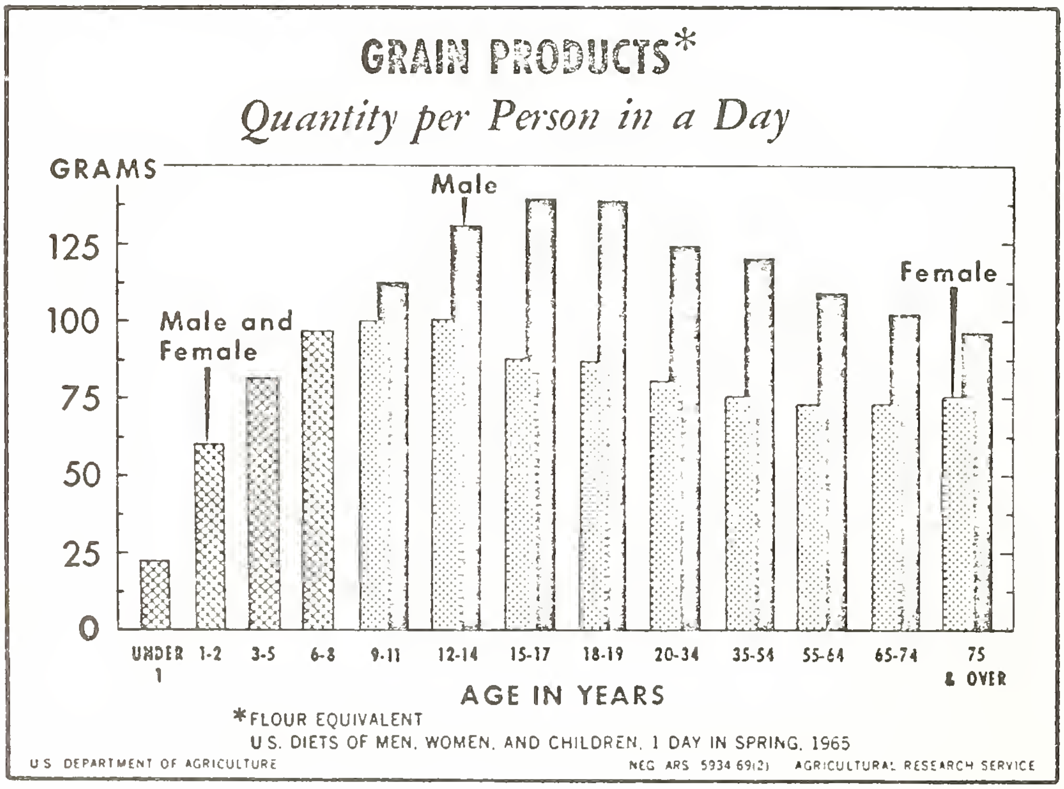


Figure 6.

Table 1.—*Consumption of purchased bakery products in U.S. households, Spring 1955 and Spring 1965*[1]

Bakery products	**Quantity per person in a week**		**Percent change**
	Pounds 1955	*Pounds 1965*	
Bakery products, total	2.01	2.32	+15
Bread, total	1.41	1.32	– 6
White	1.20	1.18	– 2
Whole wheat	.09	.06	–33
Other	.13	.09	–31
Baked goods, other than bread, total	.60	1.00	+67
Crackers, total	.14	.18	+29
Sweet	.03	.03	0
Not sweet	.11	.15	+36
Rolls, total	.11	.19	+73
Plain	.07	.10	+43
Sweet (including Danish pastry)	.05	.09	+80
Biscuit, muffins	.03	.08	+167
Cakes	.11	.14	+27
Pies and tarts	.06	.10	+67
Doughnuts	.04	.05	+25
Cookies	.11	.24	+118

[1] Breakdown may not add to total due to rounding.

Source: USDA Household Food Consumption Surveys, Spring 1955 and 1965. Report 6 (table 17) and unpublished data.

Fortification of milk would contribute most importantly to the intake of iron by preschool children, but also would be significant to the intake of girls and women.

Improvement in nutrient composition through varietal selection or genetic development.—Let us consider nutrients for which deficiency is not as marked as for iron—for

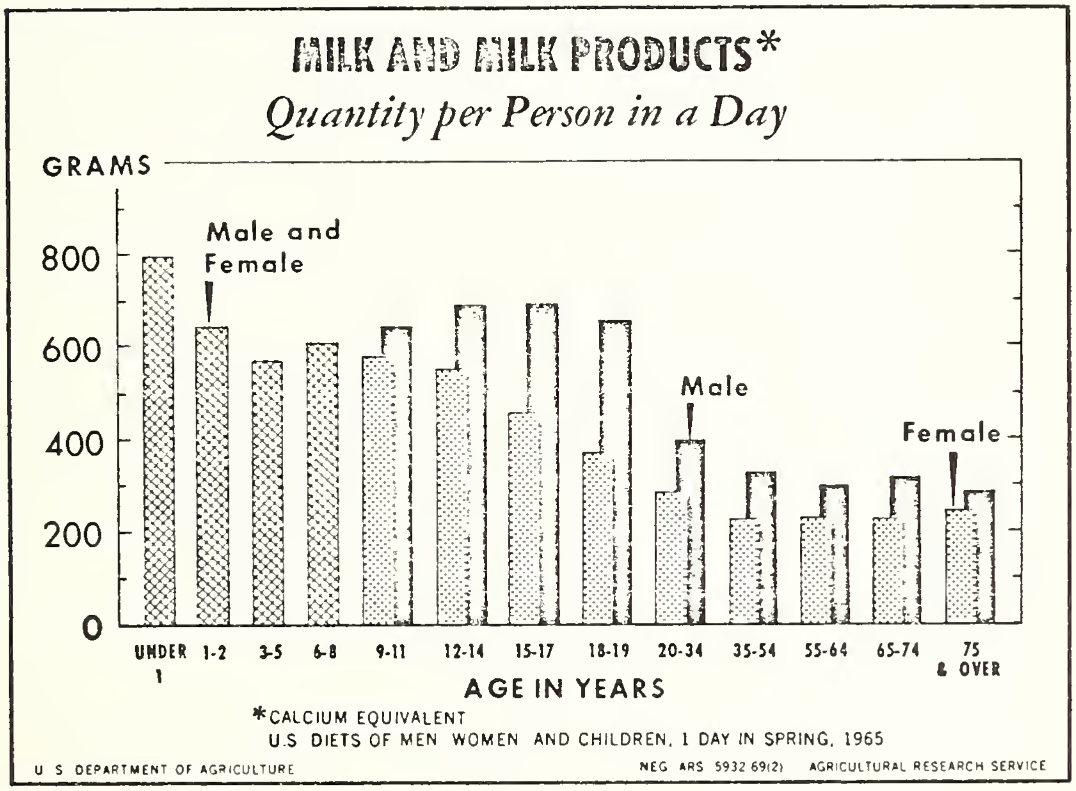


Figure 7.

example, B-vitamins, vitamins A and C, and protein. Although cereal products serve as a major source of calories, they also provide important amounts of protein. It is in respect to protein that recent findings have shown that remarkable improvement can be made both in increasing quality and quantity. The outstanding example is corn for which the *Opaque-2* and *Floury-2* mutant strains were discovered to have protein of nutritional quality comparable with milk protein. Corn breeders all over the world are working hard on introducing these genes into high-yielding hybrids.

Findings for other grains have not been as dramatic. But wild strains of oats, which contain 50 percent or more protein than domestic varieties, have been found. Screening studies for wheat, sorghum, and millets indicate there is enough genetic variability in the content of total protein and relative proportions of amino acids to warrant further research on these as potential sources of more and better protein.

Fruits and vegetables are the main source of the vitamin C and vitamin A value of our American diet. A wide range occurs in the content of these nutrients among the various fruits and vegetables and in many cases among different samples of the same fruit or vegetable. Different kinds of citrus, for example, are not equally rich sources of vitamin C. Values for three kinds of citrus fruit, tangerines, tangelos, and grapefruit, at different periods in their harvest are shown in figure 8.

Oranges are a dependable source of vitamin C. Nevertheless, a wide range in content is to be found. Results from thousands of analyses have shown that values may range from less than 20 to more than 80 milligrams of the vitamin in 100 grams of juice. Variety accounts for some of this difference. Average values for vitamin C in the juice from oranges of important varieties at different periods in their harvest season are shown in figure 9.

Apples are an example of another fruit in which variety has an important relation to content of vitamin C. A relatively little known variety, Willow Twig, produced in the Midwest has about 19 milligrams of the vitamin per 100 grams of apple. This is about three to four times the content for the Delicious, a variety which is produced and consumed in very much larger quantities. Other varieties of apples with relatively high levels of the vitamin include Northern Spy and Yellow Newton with about 16 and 14 milligrams, respectively, per 100 grams of apple. Some European grown varieties also have higher levels of vitamin C than the important commercial varieties we produce.

The vitamin A value that we have used in

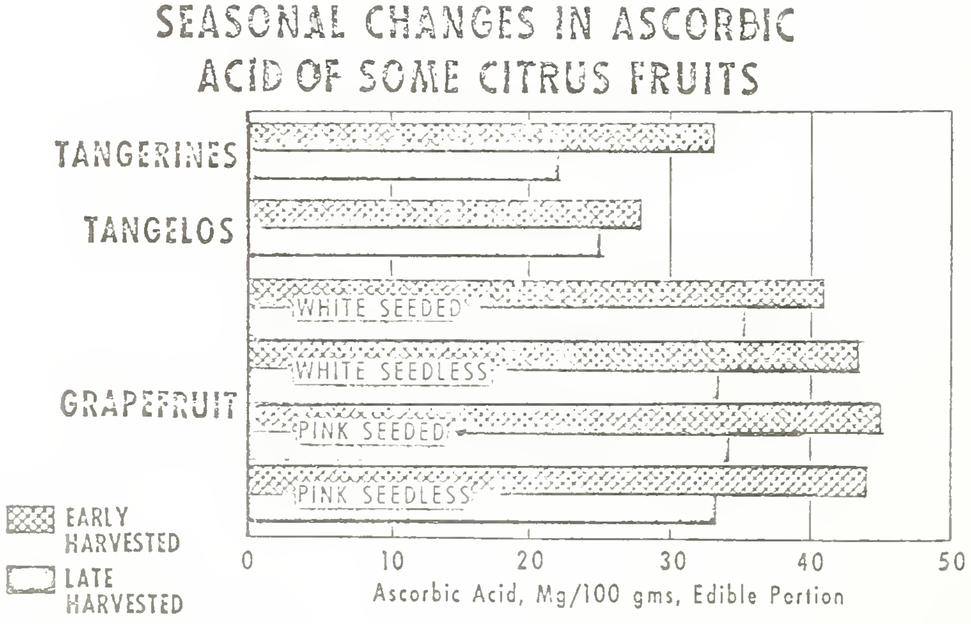


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Figure 8.

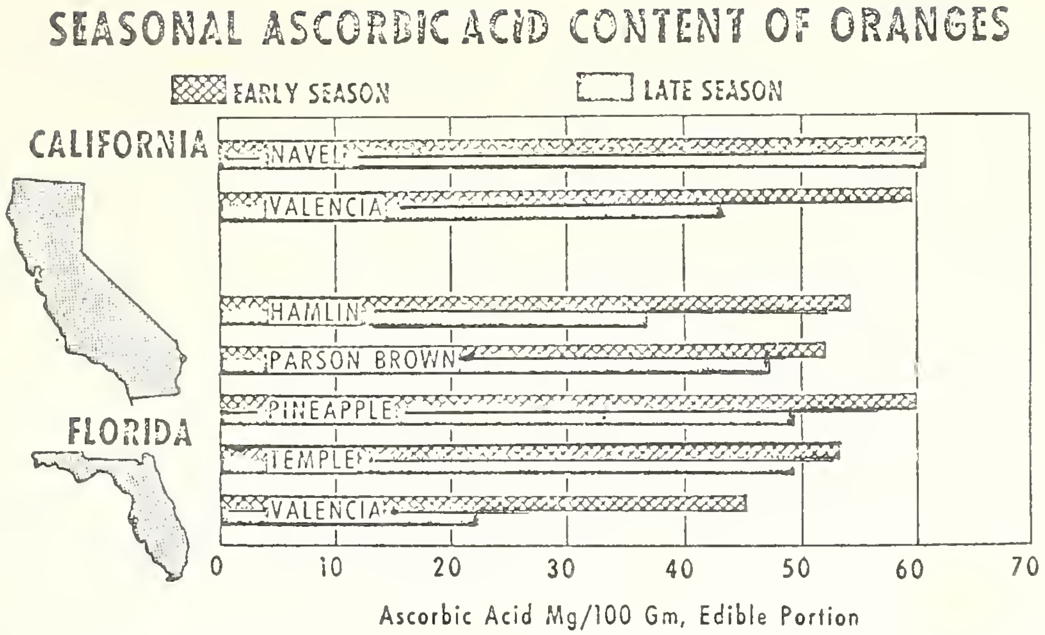

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Figure 9.

evaluating supplies of sweetpotatoes has increased over the years from around 7,700 international units (I.U.) per 100 grams in the 40's to about 8,800 in the 60's and may continue to increase as new varieties having flesh of deep-orange color are developed and replace older varieties with light-colored flesh. Varieties, such as Goldrush, with particularly high vitamin A value bring up the weighted average figure that we apply to the stocks used for food. In some countries the varieties that are important have very little color. The nearly white-fleshed kinds as Southern Queen have only about 100 I.U. per 100 grams. They are not used extensively for food in this country.

Curing and storage also are important factors affecting the vitamin A values of sweetpotatoes and their control in relation to nutrient content deserves more research attention. In conjunction with these factors, variety needs to be considered, as there appears to be a difference among the varieties in the behavior of carotene during curing and storage.

The introduction and popularity of the pink- and red-meated grapefruit pose questions on the vitamin A value of these fruits. To what extent are the pigments that are present in these grapefruit biologically active as sources of vitamin A value? Similar questions could be asked concerning the basis for the vitamin A values for many other foods—apricots, oranges, tangerines, tomatoes, peaches, squashes, and others.

New varieties of tomatoes, for example, have been developed that lend themselves to mechanical harvesting and processing. Some are being marketed fresh. For years tomatoes, whether fresh or canned, have been an important source of both vitamin A and vitamin C. We need information on the nutritive values of this important commodity as it is currently produced and marketed.

New varieties of potatoes are also being developed. The breeder should have information on the content of vitamin C, B_6, iron and other mineral elements, nutrients that potatoes are expected to provide in generous amounts to assist in the selection of the varieties. About half of the potatoes marketed at retail are in one or another of various processed forms. Data are needed, therefore, on the effects of processing on the important nutrients in new varieties of potatoes.

Carrots, another important vegetable crop, are rich in vitamin A value which is derived principally from beta carotene. Values may range from 2,200 to 47,000 I.U. of vitamin A per 100 grams of carrots with variety and stage of maturity accounting for much of this wide range.

The mineral element content of foods is also subject to variation. So few controlled studies have been made, however, that it is not feasible at present to relate the level of major or minor mineral elements to such factors as variety, maturity, cultural and production practices, or other factors that may be of significance.

Obviously, we need to have much more data on the composition of our food supplies and our foods as we eat them. As new products are developed, whether by breeding or by manufacturing processes, it is important that attention be given to what is happening to their nutritive values.

Possibilities of improvement in nutrient composition of food through improved processing methods.—The maximum nutritive values of fruits and vegetables are only realized in ideally grown, freshly harvested commodities which are promptly prepared for consumption. Obviously, present day growing, processing, storage, and food distribution methods do not allow the practical realization of this ideal. The reasons for this are many and can be broken down into varietal and growing factors as mentioned earlier, harvesting and preprocessing factors, processing treatments and procedures, storage and distribution practices, and preparation and cooking methods before consumption.

Of the three main food preservation methods (for example, canning, freezing, and dehydration), the greatest store of information on nutrients and nutrient retention has been accumulated for canned foods. This data has largely been obtained under the auspices of the National Canners Association.

While there is a considerable reduction in vitamin C content of some canned fruit and vegetables as a result of canning operations, the "C" content of other products, such as orange and grapefruit juice, is well retained (compare tables 2 and 3). One of the big factors in retention of this vitamin is rapid 0_2 removal before or during heating. In leafy vegetables, removal of 0_2 during blanching is rather slow. The combination of the two factors appears to cause appreciable losses in this processing step. On the other hand, retention of vitamin C in deaerated orange or grapefruit juice is exceptionally good. Another important factor in nutrient retention in canned foods is variation in the heat process requirements for different products. The lower time-temperature process requirement for acid foods, such as fruits and fruit juices, is more favorable to vitamin C retention than the process requirements for nonacid foods such as vegetables.

Table 2.—*Range of vitamin C content in commercially canned fruits and vegetables*

Product	Samples	Vitamin C
	Number	*Mg./100 g.*
Spinach	56	3-35
Tomato juice	140	3-30
Peas	209	3-14
Peaches	19	1-4
Orange juice	36	11-52
Green beans	96	1-7

Table 3.—*Range of vitamin C content in commercial packs of frozen fruits and vegetables*

Product	Lots	Vitamin C *Mg./100 g.*
Strawberries	55	30-70
Raspberries	16	10-14
Peaches[1]	50	20-50
Orange juice	–	35-60
Green peas	14	13-25
Spinach	6	38-50
Cauliflower	10	41-64
Green beans	19	4-13

[1] Fortified with Vitamin C.

If practical procedures could be developed to reduce the heat resistance of bacterial spores, the process schedules for vegetables could be reduced. Such a development would not only increase the retention of nutrients, but also improve the palatability of some of the commonly canned vegetables. Efforts along these lines have been and continue to be a part of the program at our Western Regional Research Laboratory. Although this may sound simple, it has proved to be a very complex problem. It has involved very basic studies of spore physiology and biochemistry dealing with the mechanisms of spore germination and dormancy. Within recent years there has been the very encouraging finding that spores can be manipulated chemically to reduce heat resistance. To take advantage of this discovery and its potential benefits, the program has been modified to determine whether all spore forming bacteria associated with the spoilage of canned foods can be manipulated—an essential research step towards commercialization of this discovery.

Compared with canning, freezing of fruits and vegetables is a relatively new method of food preservation. One of the most obvious and greatest advantages of freezing heat sensitive products such as most vegetables is the retention of fresh flavor and color. Fortunately, flavor and color retention in frozen fruits and vegetables is closely paralleled by nutrient retention. The freezing process itself causes essentially no loss in nutrients. The pre-freezing treatments, such as blanching and water cooling, cause losses of vitamin C and other nutrients by leaching and oxidation if enzyme inactivation is not complete or rapid enough. Reexamination of enzyme inactivation procedures and water cooling methods in commercial use would appear to provide useful information for realizing maximum quality and nutrient retention. Prevention of leaching losses of water soluble nutrients has a double advantage—it maintains more of the nutrients in the food product and keeps them out of the plant waste waters, wherein they represent a pollution problem.

For most retail packs of frozen fruits, blanching is not employed; hence, the capture of fresh fruit characteristics is further enhanced. Additives, such as dry sugar and sirups, usually incorporated in frozen fruits also help preserve the oxidation sensitive vitamin C. In frozen peaches, vitamin C is actually added as an antioxidant to prevent discoloration of the fruit during storage and thawing. The amount added (35 to 55 mg./100 g.) is usually two to three times greater than that which is naturally present in the fruit. A 100 g. serving of frozen peaches then provides a significant proportion of the recommended adult daily allowance (75 mg.) of this vitamin.

The largest losses of vitamin C in frozen fruits and vegetable occur during storage at unfavorable temperatures (table 4). If temperatures of 0° F. or lower are maintained, vitamin C and other nutrients are retained almost perfectly for 6 months to 1 year. Unfortunately, temperatures in the distribution chain often rise well above 0° F., and the losses in vitamin C are proportional to the integrated time-temperature experience.

Table 4.—*Retention of vitamin C in various frozen fruits and vegetables during storage.*

Product	**Percent retention after 6 months** **−10° F.**	 **0° F.**	 **10° F.**
Orange juice[1]	100	100	95
Strawberries[1]	100	100	81
Strawberries	100	95	50
Peaches	100	97	44
Spinach	100	98	73
Peas	98	95	72
Green beans	96	91	50
Cauliflower	95	88	48

[1] Packed in hermetically sealed cans. All others in oxygen permeable packaging.

Another important factor in vitamin C retention during storage of frozen foods is the quality of packaging material. Vacuum packed hermetic containers preserve practically all of the original vitamin C content even at unfavorable temperatures. Packaging materials which allow even small amounts of 0_2 to reach the product cause losses that are proportional to the time and temperature of storage. Thus, it is clear that maintenance of proper temperatures is one of the most important factors affecting retention of vitamin C in frozen fruits and vegetables. Even with inferior packaging materials, nutrients are well retained if temperatures are maintained at 0° F. or lower. During an extensive study on stability of commercially prepared frozen fruits and vegetables, it was found that color and flavor losses were generally correlated to losses in vitamin C. All the conditions which gave maximum color and flavor retention also gave maximum vitamin retention. This is indeed fortunate for frozen fruits and vegetables because the acceptability of these items is related to their desirable color and flavor rather than their nutritional adequacy.

Perhaps the most important losses in vitamins and nutrients of both canned and frozen fruits and vegetables occur outside the areas of processing and storage. As mentioned earlier, variety, growing and harvesting practices and preprocessing handling can affect nutrient content enormously—far more than can be salvaged by altering presently acceptable processing operations. Essentially the same can be said for thawing or cooking or preparing for actual consumption. This does not, however, reduce the need to minimize losses in nutrients through proper processing.

Unfortunately, varieties are generally not selected for their nutrients or color or flavor, but for disease resistance, yields and other economic advantages. With regard to cooking and preparing for consumption, however, better methods and better education in the use of those methods should make for better utilization of the available nutrients. Some of the newer convenient forms of frozen vegetables, such as "boil-in-the-bag," may result in better retention of nutrients during cooking and serving by minimizing cooking time or eliminating extraction of nutrients by cooking waters.

In summary, there are substantial opportunities for improving traditional foods with respect to their contribution of specific nutrients to the diet. For certain nutrients, iron for example, this may be best accomplished by fortification. For protein and vitamins, some of the genetic selection has demonstrated possibilities for significant improvement in composition in certain crops. More attention generally should be given to improved nutrient composition as an objective in breeding programs. A third opportunity for improvement lies in maximum preservation of nutrient content as it occurs in present crops through harvest at optimum maturity and by minimizing losses in handling, processing, and preparation for the table.

DISCUSSION

QUESTION: You mentioned fortification of milk with iron. We know that this does affect the flavor of milk and shortens the shelf life. Have you checked on the vitamin content as a result of putting iron in it? Does it cause a faster deterioration? We know it knocks out vitamin C pretty much. Have you checked on the nutrient loss?

DR. SENTI: No. I don't have information on the effect of iron fortification on vitamin C in milk. However, with the ferric ammonium citrate, results of our tests show that the flavor stability was quite good, both in our laboratory tests and in larger scale processing trials that we carried out. From a flavor standpoint, prospects for fortification would appear to be optimistic. There may be questions about interaction, particularly vitamin C (but milk isn't an important source of this vitamin).

QUESTION: My question pertains to the variability of nutrient content of our so-called traditional natural foods. I was talking with the director of research of a large food company recently and he said we can put our products on the shelf with a certain guarantee of nutrient content of vitamins and minerals and they will last 6 months, 9 months, and so on. Now, as we look at natural foods, we know they vary in composition as they are produced. As they go through processing, what should we be thinking of in terms of fortification, stabilizing, or standardizing some of these nutrients that are in natural food products? It puts us at a considerable disadvantage if we know their actual value versus some value we have just put over here and say this is an average value. The dietician calculates and adds the value as it goes on, but we don't know that it's necessarily there.

DR. SENTI: You are quite right. This is really a problem, and I don't know that I have the solution to it because, as you pointed out and we showed on the slides, the stage of harvesting and the degree of maturity have large influences on the nutrient composition. If a processing plant is going to operate all season long, this presents some pretty large difficulties in harvesting at optimum maturity for nutrient composition.

Nutrient composition also can deteriorate during storage and transportation before processing and measures can be taken to minimize such deterioration. In the canning operation itself, if one could reduce severe processing conditions, that is, temperature and time, vitamin losses in the canned products might approach those found in frozen fruit or frozen vegetables.

QUESTION: The thing that bothers me is that the Food and Drug Administration has a tendency to let you standardize a formulated food to adapt a nutrient composition; they will not let us do something similar to that on natural and traditional foods.

DR. SENTI: I guess there's a considerable background that influences them in their decisions on what will be permitted to be added and what won't be added.

QUESTION: Are you suggesting that individuals that are working in this area should get together?

DR. SENTI: People are motivated to work in areas in which there is general interest and publicity. Because of the food situation in the developing countries, the need for protein has gotten a lot of emphasis, undue emphasis, I believe, relative to the need for other nutrients and calories. It's only as concern develops over a particular problem that effort will be put in this problem.

I think there is an aspect of food composition which is going to command more attention and this is the problem of possible toxic natural constituents. We have just had a recent example—a new variety of potatoes that was found to have a high content of the alkaloid solanine. In developing this variety with the desirable properties of high solids and high protein, adventitiously there was also developed high solanine content. The breeder and the processor need to work together to assure that the product is satisfactory in composition as well as in agronomic and processing properties. In certain cases, we may know what undesirable constituents to look for. In other cases, we may be tricked. As varieties are developed for disease resistance, insect resistance, the constituents that are responsible for that resistance may not be good for humans.

Generally, I think there needs to be more coordination between the breeder and the food scientist. The processor should seek not only good processing qualities such as texture and color—but also should be concerned about the content of nutrients.

QUESTION: I would like Dr. Senti to comment on the recent White House Conference. It seemed to me in a particular panel that I participated in, there was a strong anti-USDA, when in fact those of us who have been involved in supplying the food for the American public realize that from this well of information that many of these things are available. Do you think there is anything that we should do to improve the image of the system that we have had in this whole area of nutrition and health?

DR. SENTI: I am sure we should. Just how to do that is difficult to say. Any organization or institution that has been associated with food and food programs also receives the criticism for any aspects of these programs that don't come up to the ideal. It might then be proposed that the programs be moved to another organization which might not do any better, but at least hasn't been associated with the shortcomings of the program. This is a normal reaction, but I think agriculture has taken an underserved whipping. Pesticides do cause problems; problems are encountered in inspection services now and then; and food distribution programs have not been as generous as some would like. But the critics forget that agriculture has provided the Nation with quality food in bounteous amount at relatively low cost and that the marketing and inspection system does provide wholesome food that meets high microbiological and quality standards. This isn't advertised. Sometimes we hesitate to do it in our publicity because we are afraid that in telling about our efforts to keep it safe, it will make people fearful that it might not be safe, that there is a problem somewhere. So we do need a better job, yes.

QUESTION: It seemed to me there was a tendency of the people to get the wrong idea of why people are not beginning to add iron to milk or add more iron to cereal. It wasn't the fault of those doing the research area, but in the laboratory. What I am saying is that maybe we've been playing up the negative end of this too much.

DR. SENTI: You are suggesting that we would promote fortification? The Food and Drug Administration has to approve fortification of a food product and they have to give careful consideration to the impact of fortification on intake of the added nutrient by various population groups to assure that no one would get harmful amounts. The Millers National Federation and the American Bakers Association are very much interested in iron fortification of flour and bread at higher than current levels set for enriched products and have made such a proposal to the Food and Drug Administration. The Department is working with these groups and the Food and Drug Administration on the proposal.

AGRICULTURAL ECONOMICS—EXPORT POTENTIAL FOR SOUTHERN CROPS

by

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The annual outlook conference in Washington was recently completed and the detailed export potentials for specific crops for the next 12 months have been spelled out. I will not duplicate these appraisals but will look forward beyond the next year to the next 5 to 10 years. In terms of research planning, we have already made the right or the wrong decisions affecting 1970; we made them 5 to 10 years ago. Today, we need to look ahead as to what is likely to be 5 to 10 years hence and begin now to develop the research needed to answer the questions that will be asked at that time.

In terms of export potentials, we must look at the overall framework of international commercial agriculture first before looking at specific commodities. The overall demand and supply situation for agricultural products on a worldwide basis will be affected greatly by political developments and by general economic activity. If we have reasonable peace and stability in most of the world, one set of demand and supply conditions will prevail; if we have another 1940 to 1950 world war situation, there will be major differences. In a similar manner, if we have a worldwide depression as in the early 1930's, or even a major recession, the demand-supply situation will be greatly different from a period of fairly active and relatively stable business conditions. To make my job simpler, I am assuming that there will be no major world war and that localized conflicts such as Vietnam and the Near East will be no worse and, hopefully, somewhat improved in the next 10 years. I am also assuming that while there will be no vast rapid improvement in world business conditions, there will be reasonable stability in worldwide economic activity and a slight but gradual increase in world trade during the period.

Within this framework, the next question to be asked involves the potential worldwide demand and supply of agricultural commodities in general. On the demand side, world population has increased 15 percent from 1964 to 1970, or at a rate in excess of 2 percent annually. In some of the developing countries, Latin America, Asia, and Africa, this rate has been at the level of 3 percent or more. Although there are a few encouraging isolated spots of hope indicating that some day the rapid increase in world population will be retarded, such as in Japan and some countries of Western Europe where the annual rate is only 1 percent, the general prospects for the next 10 years for the world as a whole is a continued rate of increase of more than 2 percent annually. To hold present per capita consumption levels, by 1975 we will need at least 12 percent more food and by 1980 at least 25 percent more than was available in 1970.

On the supply side, developments in the next 10 years are not so clear. From the 1960-64 period to 1969, the world production of all grains increased 22 percent while population went up 15 percent. Some analysts have termed the 1965-69 period as the time of the "green revolution" with this rapidly increasing production of grain forecasting a coming period of abundance, of self-sufficiency or surpluses in many countries that have been traditionally deficit-food areas, and a major decline in world trade in farm products.

Most of the recent publicity concerning the increase in grain production from 1965 to 1969 has attributed this change to the development of new high-yielding varieties of wheat and rice now being widely used in many parts of the world. Assuming the cause was primarily the new varieties, an additional forecast can be made that as these varieties are further spread and intensified, the production increase will be continued.

This appears to me to be a false assumption and one which could place the world food situation in a very difficult position in a very short time. The increase in world grain production occurred mostly in a 2-year period—from 1966 to 1968. From 1968 to 1969, total grain production increased very little and per capita production declined. The very rapid jump in production from 1966 to 1968 occurred at the time new varieties of wheat and rice were being expanded and no doubt these improved types had a major effect on production. However, this also happened to be the period in which overall climatic conditions affecting yields greatly changed for the better. The chances are good that weather had a greater impact on production than the new varieties. Also, this happened to be a period in which the worldwide fertilizer industry found itself overexpanded and released large supplies of fertilizer at a very low price to many nations.

It was the fortunate combination of three major factors—good weather, improved varieties, and abundant low-priced fertilizer that caused the grain production increase. My estimate is that about 50 percent of the increase was caused by the weather, 25 percent by increased availability of fertilizer and other inputs, and 25 percent by the improved varieties plus the intensified rural education and training program that accompanied them.

Looking to the future, the improved varieties will continue to be used in more and more areas. They will have a further impact on increased yields, but this will not be as dramatic as in the recent past. Although high-yielding, the new varieties of both rice and wheat so far have not met high acceptance by consumers in many areas and price discounts will retard their expansion in some areas. Also, they have been planted mostly on the better lands where increases are at a higher rate than on average or below-average soils. In addition, the rigid requirements of these new types as to water, fertilizer, and pesticide needs will make further expansion much more difficult than the initial successes.

Climatic conditions will continue to vary from year to year. Although a 10-year period as bad as 1966 for most of Asia is not indicated, a 10-year period as good as 1967-68 is not in prospect. The 1969 experience provides an indication of the more normal expectation. In addition, the fertilizer industry with a relatively low profit level and severe marketing problems in recent years is not expanding currently at the 1966-69 level and prices are likely to increase.

To summarize the demand and supply situation for farm products in the next 5 to 10 years, sufficient encouraging factors indicate enough expansion in production so that no massive famines are in sight, assuming reasonable weather conditions exist. However, there are no indications of massive surpluses and with the increase in population, there is likely to continue to be world trade in farm products as large as in the late 1960's and most likely considerably larger. There will be shifts from country to country, but overall, those who can produce them efficiently will still be exporting large quantities of wheat, rice, sugar, cotton, corn, feed grains, soybeans, tobacco, livestock, and livestock products. Competition will be sufficiently keen, however, that prices in general may be 10 to 20 percent below late 1960 levels for many products.

With this overall situation, where do we stand in the South in regard to specific commodities of importance to us? We depend on export markets for a substantial part of our cotton, rice, soybeans, tobacco, specialty processed food products, and our prices for corn and other feed grains, dairy products, and poultry products are greatly affected by export demand. Where do we stand in regard to some of these items?

Cotton.—Overall world trade in cotton

changed little during the 1960's. Total world exports amounted to about 18 million bales in the 1960-63 period and was at about the same level in the 1966-69 period. During this period world fiber use increased from a 70 million bale equivalent to around 100 million bales; most of this increase was taken up by manmade fibers. Cotton's share of the world market for fibers declined from about 70 percent of the total in 1960 to around 50 percent in 1969.

In the last 10 years, foreign cotton production has expanded significantly and United States cotton producers have filled a decreasingly smaller proportion of total world markets. With the increasing use of manmade fibers along with expanded production abroad, United States exports of cotton have declined in the late 1960's to around 3 million bales annually. Exports early in the 1960's were at about twice this level.

Cotton producers in the 1970's are likely to have a hard fight to hold and to expand export markets. There are, however, several bright spots in the overall picture. The Cotton Research and Promotion Act of 1966 is beginning to have an impact in promotion and research. Producers are delivering higher quality cotton geared to competitive market demands. With the world fiber market on an overall basis increasing at about 6 percent annually, if cotton can hold its current share of world use, the potential export market will increase by several thousand bales annually. In addition, foreign producers are having increasing difficulties in maintaining recent increases in production levels. Many of these countries are just beginning to face the problems that the United States industry has faced for years and, to some extent, have found at least partial solutions. This is especially true with insect control in some of the new areas of Latin America and Asia.

Overall, there is no indication that export markets for United States cotton will disappear. However, trends in the past 10 years indicate that it will take an aggressive effort to hold current levels of marketing and even more intensified work to expand sales. There are indications that the industry realizes this and is taking the necessary steps.

Oil crops.—United States oilseed production, including primarily cottonseed, soybeans, and peanuts—all important in the South—reached a record level of around 40 million tons in 1969. Total exports of oilseeds and oilseed products brought in 1.3 billion dollars in 1969, or almost one-fourth of all agricultural exports. Soybeans and soybean products made up 85 percent of this total.

The 1969 United States total oilseed production was greater than the expected utilization during the current marketing season. This means that oilseed carryover stocks will be higher than last year and farm prices of soybeans, peanuts, and cottonseed are likely to be near support levels this fall. However, the immediate and longtime prospects for oilseeds, and especially soybeans, are good.

Lower United States prices and expanding export demand are expected to increase shipments abroad to a level of about 15 percent higher than last year. The chances are good that this level of demand will be maintained and increased in the next 5 to 10 years. United States soybean growers cannot expect 3 dollar beans. It was the 3 dollar beans of 2 years ago that encouraged Russia to greatly expand sunflower plantings and that stimulated Malayasia and other Asian countries to increase oil palm developments. However, if the industry can make a modest profit at $2.00 to $2.25 beans, then export markets are likely to exist for even larger volumes than at present.

The increased population and trends toward more use of soybean oil per person and more livestock and livestock products per person are helping to increase soybean consumption levels. Also, the production of competitive food fats and oils has been slowed down somewhat by the downward adjustments in the 1968-69 period in soybean prices. The major significant impact on world soybean markets caused by competitive products is likely to occur 3 to 8 years hence. Under favorable climatic and soil conditions, the African Oil Palm can produce three to five times the edible oil per acre than any other known oilseed crop. Plantings are being greatly expanded in Malaysia and in other countries in Asia. Expanded production is also in process in parts of Africa and experimental commercial-size plantings are now being developed in Latin

America.

Fortunately for the soybean producer, it takes 4 years for the oil palm tree to produce the first cluster of nuts and 8 years for it to get into maximum production. If plantings continue at the present level, soybeans will have a major competitor from this crop. Fortunately, since population pressure by this time will require the additional supplies, the longtime market still looks reasonably good.

Rice.—In recent years, about three-fourths of all the rice produced in the United States, mostly from the Southern States of Louisiana, Texas, Arkansas, and Mississippi, have been exported. Without these substantial export markets, the southern rice industry would be seriously retarded.

Rice exports from the United States have increased from about 1 million tons annually in the early 1960's to about 1.8 million tons a year in the 1968-69 period. About one-half of these exports, however, have been under various government programs, primarily Public Law 480 sales, and only one-half have been commercial sales for dollar markets. In 1969, dollar sales declined to less than one million tons and government program sales amounted to more than one-half of total exports. The reduction in dollar sales was caused primarily by the rapid expansion of rice production in some areas in the 1968 period because of factors mentioned heretofore. The increase in government program sales was primarily due to government assistance activity in South Vietnam and Indonesia.

World rice production increased from 243 million metric tons of rough rice in 1966 to 269 million tons in 1967 and 1968 and to 276 million tons in 1969. This amounted to an increase of more than 10 percent between 1966 and 1967, but an increase of less than 5 percent between 1967 and 1969. In this period, the most substantial increases occurred in India, with an increase of 14 million tons from 1966 to 1967, with stabilization from 1967 to 1969, and 4 million tons in Mainland China from 1966 to 1967, followed by stabilization in the next 2 years. Although the relative impact of weather conditions as compared with the new improved varieties is a subject of some controversy, it should be kept in mind that a large part of the substantial increase in world rice production occurred in the countries where the new varieties were not in major use at the time. As long as most of the ricelands of Asia are dependent on natural rainfall, the weather will continue to be the most important factor affecting total rice production in the world.

World rice trade is a very small part of total production. In the 1967-69 period, only about 7 million tons of milled rice moved from one country to another. This represented less than 4 percent of total world production. Thus, small changes in supplies result in large changes in export prices.

In general, the drastic world rice shortage which existed in the 1965-67 period has been changed to a position of supplies at least keeping up with population growth and in some areas a buildup of surpluses. The international rice market has changed from a sellers' market in 1966 and 1967 to a selective buyers' market in 1969 and 1970. World prices for quality long-grain rice have declined from f.o.b. exporting country prices of almost $10.00 per hundred pounds in late 1966 to about $8.50 per hundred pounds in early 1970. Importers have become quite discriminating as to quality, specifications, insect infestation, and delivery dates. However, prices have not declined to the level of $6.00 to $7.00 per hundred pounds which prevailed from 1960 to 1965.

Some analysts have been very pessimistic as to the future of export markets for rice. A realistic picture of the situation, however, indicates that even with the recent increases in production, which are not likely to be maintained year after year, there is still no massive world surplus of rice. The current world situation is one in which rice markets have adjusted from the mid-1960 pattern of very scarce supplies and high prices to one of generally adequate exportable surpluses and lower but not sacrifice prices.

The United States situation is complicated because about one-half of our exports in recent years has been under government programs, which at best are temporary. Any sudden changes in these programs will result in serious market problems. Until all United States sales are for hard-currency competitive markets, this problem will continue. The efforts of the industry to sell quality rice on its merits are gradually paying dividends. In the Near East, for instance, United States' high quality, clean, long-grain, nonscented rice is gradually replacing the traditional scented, but lower quality, milled rice from the region.

World rice prices will react in the future as they have in the past—they will go up and down. The chances are that the pessimistic forecasts of massive surpluses, disappearing export markets, and greatly depressed export markets, will not materialize. In planning for rice exports over the next 5 to 10 years, an assumed price level of world prices at a point near the present export price of $8.50 per hundred pounds for good quality, long-grain rice to a level about 20 percent below this price is a reasonable target. This will mean prices of from $160 to $180 per metric ton for good quality rice and $120 to $140 per ton for lower quality, short-grain types. If the United States industry can improve efficiency so as to produce at these market levels and still make a reasonable profit, it will continue to be the world's largest exporter of rice.

Other important exports.—Tobacco has always been an important item in export sales in the South, especially, and in some of the Southeastern States. Flue-cured cigarette leaf represents the largest part of tobacco production and sale, with burley tobacco the second most important United States tobacco item. United States exports of tobacco are more than 80 percent cigarette leaf, primarily cigarette leaf flue-cured with some burley. Slightly more than one-half of all flue-cured tobacco exports moving into world markets are from the United States.

The indications are that increasing competition from many countries will force the United States to fight increasingly harder to maintain export markets for tobacco. However, the longtime experience and know-how combined with the world-recognized higher quality of the tobacco they export should maintain our position as the world's most important exporter of tobacco. The problem here is to maintain quality at reasonable prices.

Corn and other feed grains, especially grain sorghum, also offer opportunities in the South. Export markets for feed grains in the 1970's are likely to increase. The major competitive issue has been the increasing world stocks of wheat available for export and use as feed. With the world supply of wheat increasing rapidly and demand for milling wheat declining, a larger proportion of the world wheat crop is being used for animal feed. As this situation adjusts in the early 1970's, however, an increased demand for corn and sorghum as feed sources is likely to develop.

Total United States feed grain exports in the 1969-70 marketing year are expected to be about the same as last year's shipments of more than 18 million tons. The level of these shipments greatly affect the movement and price of corn and grain sorghum in the South, even though most of the production is consumed domestically, and the indications are that there will be a gradual increase in the demand for corn and grain sorghum in the 1970's. Other countries, such as Argentina and South Africa, are expanding production of feed grains and will offer stiff competition. The extent to which we can meet this competition will determine the longtime markets for feed grains in international channels.

Livestock products, especially poultry meat, also offer export possibilities in the South. Exports of broilers increased 10 percent from 1968 to 1969. The outstanding quality of United States broilers is likely to stimulate further increases in these shipments. If costs of production can be held to reasonable levels, these markets can be expected to expand. Poultry markets in Latin America and Asia, where the relative ratio between poultry and red meat prices is traditionally greater than in the United States, should stimulate these markets. While poultry is usually the less expensive meat in the United States, it is the most expensive meat in many other areas.

In conclusion, the overall picture as to potential exports of southern crops is good. The demands exist; the markets are waiting. Taking advantage of them, however, depends on the South being able to meet increasing competition with more efficient production. High yields alone are not enough; meeting the competition will require high yields at relatively low costs and of high quality standards. In planning our research for the 1970's, this is our challenge. As one of my good cotton-grower friends stated to me recently, "Doc, I have the answers as to how to get high yields—what I need to know now is how to produce and save the crop cheaply enough to make a profit."

SESSION I: NEW DEVELOPMENTS IN PROCESSING

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PEANUTS AND PECANS

by
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"Processing" is used here in its broadest sense to mean those steps by which a farm commodity is transformed into useful products for human consumption. Neither peanut nor pecan processing methods have leapt ahead in technical advancement over the past 5 years. Indeed leaps are an unusual way for progress made through scientific research and development. It will be interesting, however, to review progress in the peanut industry over the past few years and then to examine some aspects of pecan processing.

Peanuts.—The awesome possibilities arising from the possession of moldy peanuts, especially if the fungus were predominantly *Aspergillus flavus* have dominanted peanut processing during the past decade. Although the actual blanching, cooking, and other procedures to which peanuts are subjected have changed little, the steps by which inshell peanuts are converted to shelled U.S. No. 1, wholesome, ready-to-use raw product have shifted.

Peanuts, to the best of our knowledge, should now be dug, inverted, and allowed to dry to 15 to 20 percent moisture in direct sunlight without rain interposing to rehydrate them. As an alternative, they may be picked from the vines green and dried wholly by artificial means. At any event rapid drying to less than 10 percent moisture and a minimum of heat or impact injury is imperative.

Shelling methods, consisting mainly of wedging the peanuts between a fixed hard object and a moveable hard object until the shells come off, have changed little in 20 years. The electronic sorter has come into prominence in the past few years as a device for removing off-colored, hence probably decayed or otherwise polluted, kernels.

Our preoccupation with avoiding a toxin of punitive harmful properties to humans has led to a general elevation of quality in peanut products. The search for a solution of this problem has generated much money for research, much insight into the nature of peanuts, and no real amelioration of the basic problem. It remains the primary concern of the peanut industry.

Aside from the question of unwanted natural additives, small areas of progress appear in the handling and marketing of peanuts. We now find some segments of the industry preprocessing peanuts for further processing at a manufacturing destination. Peanuts are now being blanched, dry- or oil-roasted, and shipped in aluminum containers. Each container holds over half a ton and is sealed and flushed with nitrogen before shipment.

The pollution aspects of disposing of untold tons of peanut shells is a local problem of some importance. Burning, even if done with finesse, is becoming more unseemly. Use of ground shells for fertilizer diluents or mulches, without biological, chemical, or physical treatment is a questionable practice and probably economically unsound in most instances.

Pecans.—The pecan is a noble plant that figures prominently in the horticultural enterprises of many Southern States. With, fortunately, increasing exceptions, it is cultured meagerly in that planting the tree may be the first and only culture practiced. As a general result average yield of pecans in many States is as low as 200 to 300 pounds of nuts per acre, 10 to 30 percent of which may be commercially unacceptable for any food purpose. On the other hand, yields of 800 to 1,000 pounds of good quality nuts are possible and regularly achieved by some growers who are interested in making an income from laboring with pecans.

More intensive cultivation with high fertility, irrigation, closer spacing, and nondiscing practices are coupled with mechanical harvesting. This has led to an increase in trash in the harvested crop. Cleaning has become an indispensable part of processing. Processes to remove rocks, sticks, shucks, pops, and other trash must precede drying and grading. During this process, pecans are commonly conveyed and dried in farm wagons that can be used for peanuts or other crops. Innovations in pecan cleaning equipment are emerging in the Southern States.

The most bewildering facet of pecan processing at present is the general disagreement in the industry as to shelling procedures. This is not due largely to the diversity of shellers available because this machinerey is manufactured by only a few companies. The differences in procedures in this operation center mainly around "conditioning." This is a process by which the pecan kernel is hydrated from a storage moisture content of 3 to 5 percent to a higher content so that the kernels become more pliable and less likely to shatter when the nut is shelled. As a sanitary practice to prevent kernel contamination by enteric bacteria, some pecans are conditioned by soaking in chlorinated water at ambient temperatures. In such low temperature treatments the time required for conditioning may be 18 to 30 hours. Heat treatments involving steam, or water at 180° to 200° F. are used by some operators. After shelling, kernels are cleaned of dust and shell particles by vacuum processes or further washed in chlorinated water. The kernels are then dried, often at excessive temperatures that cause oil leakage to the surface.

New developments in pecan shelling have occurred but so little research has accompanied some of these developments it appears that quality is deteriorating from some new practices. Kernel darkening after shelling is an example of a serious quality problem confronting the pecan industry of the Southeastern States.

Pecans appear exceedingly durable and impregnable to the hazards of the environment but they are not. The relative ease with which they become rehydrated by soaking or similar treatments attests to this. Pecans easily become infested with a variety of fungi and kernel molding is an enduring problem. The pecan industry has not squarely confronted this problem and promoted research in this area. Institutional research has much to do in acquiring the knowledge to advise the industry. In view of the attitude of the consuming public and governmental agencies toward food safety, a new development in the processing of pecans may well be a greater concern with all aspects of quality.

PEACH PRODUCTS[1]

by

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University of Georgia
Experiment, Ga.

(Presented by T. S. Boggess, Jr.)

Because agricultural production is inherently seasonal, and the peach is not only seasonal but highly perishable, the need for processed products to control these and to assume adequate use of the entire crop is apparent.

The development of peach products was initiated in Experiment, Ga. in 1962 and a preliminary report given by Woodroof (1) in 1965. Woodroof reported that "It is apparent that recovery or even maintenance of the peach

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[1] This work was done in cooperation with the U.S. Department of Commerce and the Southern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, under contracts 12-14-100-6853(72) and C-23-66(Neg.).

industry in the Southeast lies in the area of expanding processing and marketing, as well as in production." (Fig. 1)

Ford (1) in 1969 reported the total number of trees of all ages in Georgia decreased from 1965 to 1969. This decrease was in bearing age (3 years and older) but the number of trees under 3 years of age increased from 362,000 in 1965 to 562,000 in 1969. Three new varieties—Mountain Gold, Piedmont Gold, and Springgold—were reported for the first time. These are nonmelting Clingstone varieties used for processing only. We hope that our efforts to increase processing has been instrumental in the increase in young trees planted. Also, the percent of the total peach production used for processing in Georgia has increased from 24 percent in 1965 to 55 percent in 1969.

I. Canning as halves or slices accounts for the largest utilization of peaches as a processed product in the Southeast as well as in the United States: puree (for baby food), freezing and pickling accounted mainly for the remainder. Canning in the Southeast is entirely of the freestone Elberta type peach. But, with the introduction of the V.P.I. Clings, the Baby Gold series and other nonmelting Clingstone varieties, considerable interest in processing these, as dessert halves, is being shown in Georgia, South Carolina, North Carolina, and Mississippi. Our work for the past 5 years shows that Piedmontgold, Mountaingold, Suncling, and Baby Gold 5 to 9 have excellent canning qualities. Several hundred acres have been planted in Piedmontgold and Mountaingold for processing as canned halves.

II. The increase in production of the melting flesh cling and semicling peach encouraged our research into new ways of processing, which are applicable to both cling and freestone varieties. From this research several products have been developed.

The first to be discussed is concentrated clear peach juice which is used at present for wine stock. This method has increased the use of wine stock peach from 50,000 pounds to approximately 200,000 pounds in 4 years. A commercial company in operation in Georgia is building a new plant in the peach belt of Georgia and plans to make brandy, wine stock, concentrate puree, and drink base puree, the latter two will be discussed later. They plan to have an essence recovery unit in conjunction with the concentrate juice and puree operation.

III. *Refrigerated slices.*—Only high quality freestone (possibly nonmelting cling) fruit is suitable for this product. The methods for the preparation of fresh-sliced freestone peaches were reported by Heaton (3) and Van Blaricom (7). A refrigerated pasteurized peach slice has been reported by Harris (2).

Mr. Heaton's main purpose with this product was to make ready available fresh peach slices during the peach season, also to expand the season for fresh peaches 4 to 8 weeks which was accomplished. Some varieties had a shelf life of 10 to 12 weeks, others from 20 to 24 weeks. The primary reasons for the limited shelf life of refrigerated fresh peach slices were the loss of fresh natural flavor followed by development of a seedy flavor and gradual softening of texture.

IV. *Puree base and puree concentrate.*—We felt that a full ripe peach puree base should be made, which would help better utilize the surplus cling peaches discussed earlier, under the product—Clear Peach Juice Concentrate. Thus the process for a high quality puree base was developed.

From this research a plant was built in Georgia to utilize these soft-ripe peaches on the day that they are graded out at the packinghouse.

The puree base was used as a base for a single strength peach drink and is being marketed by a processing plant in Georgia. (Woodroof 9)

Also, because of the nature of the peach base, we were able to develop a second product by adjusting the sugar and acid in the puree, yielding a product that can be (a) diluted 1 to 1 to make a drink, (b) used without dilution as topping, (c) used in salads, (d) used in ice cream and (e) used in pastries.

Also, a third product was made by concentrating the puree fourfold. Further work will be done on this product in the future.

A fourth product was made from the puree base—drum-dried peach flakes. This product was

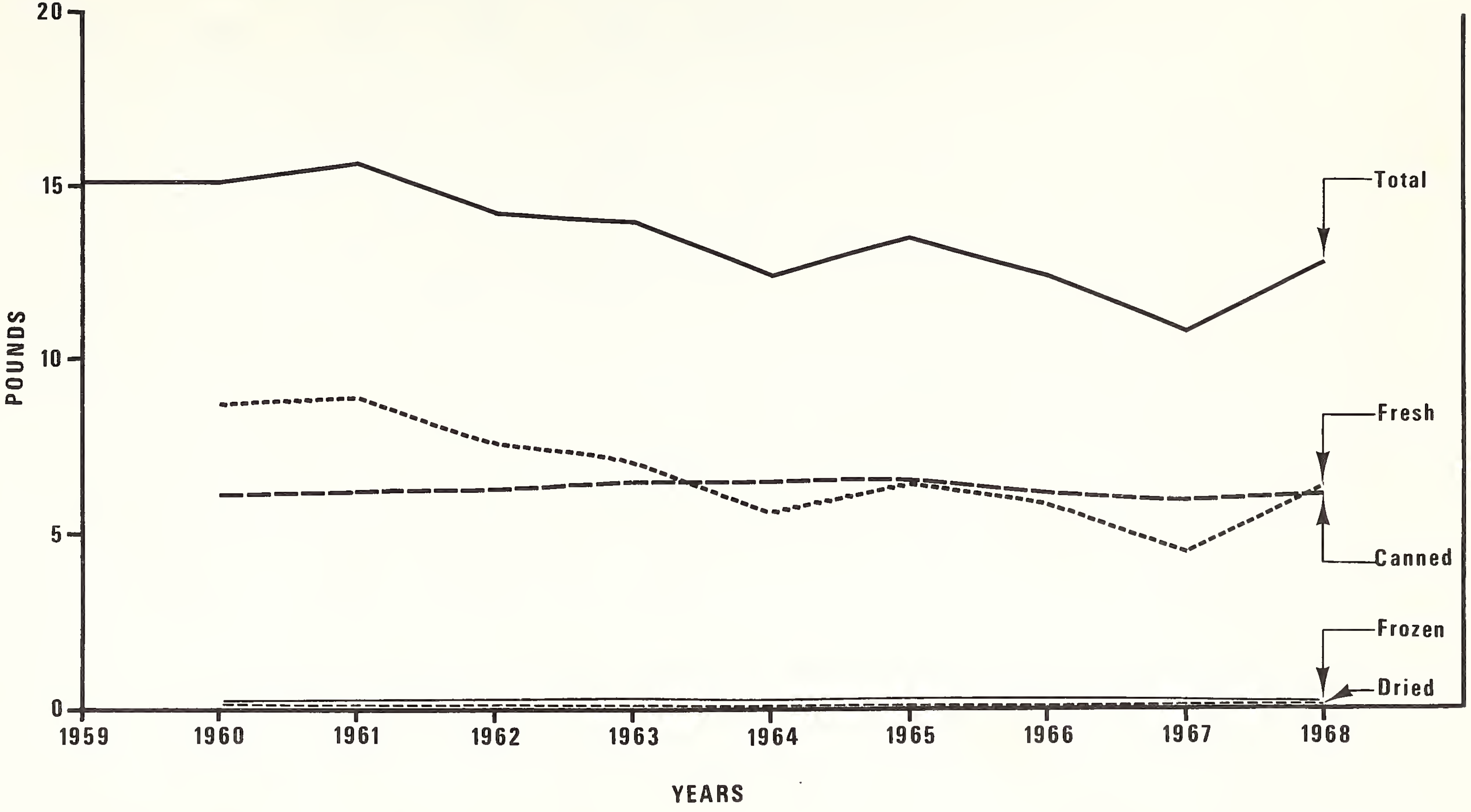
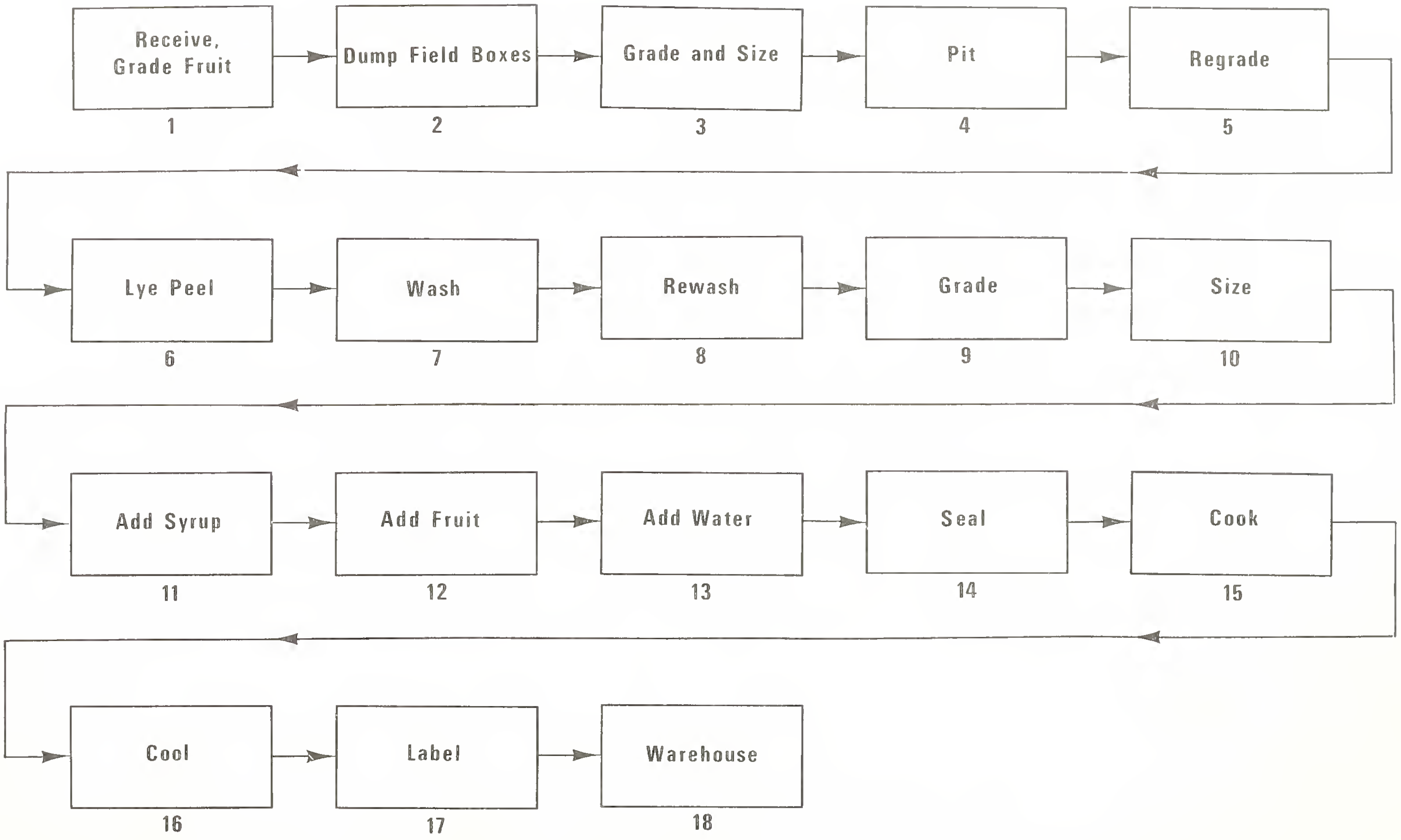
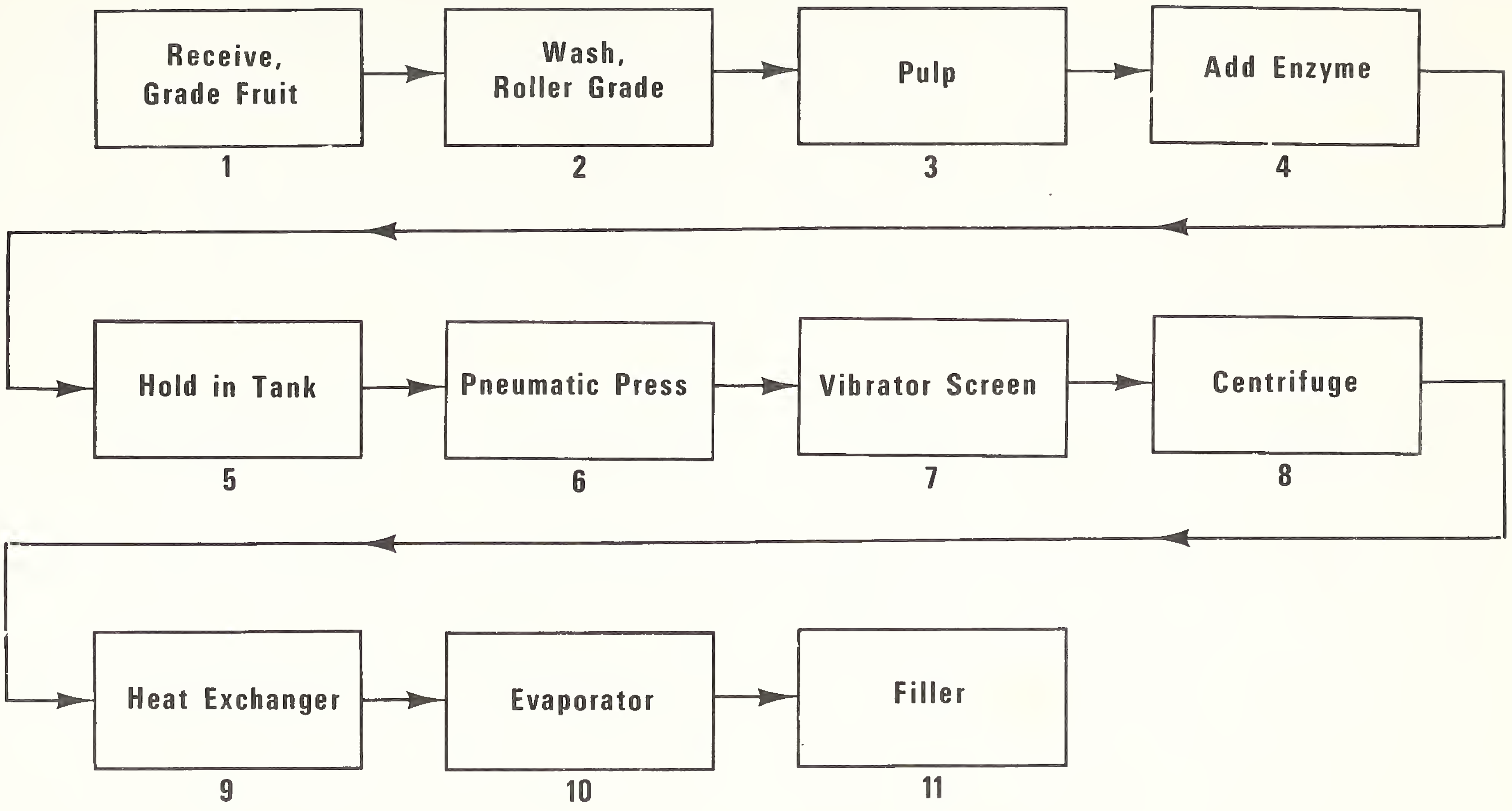


Figure 1.--Per capita consumption of peaches.

FLOW SHEET FOR CANNING PEACH HALVES



FLOW SHEET FOR CLEAR JUICE CONCENTRATE



developed with the cooperation of the Southern Regional Research Laboratory, New Orleans, La., in cooperation with our Food Science Laboratory at Experiment. We found this product very stable and easily reconstituted by using 1 part water and 1 part puree flakes and used for pastries and such. Also, further dilution to single strength juice will make an acceptable drink. Martin (5) found that these flakes could be used as a flavor product in ice cream.

V. *Pasteurized partly dehydrated peaches.*—Li (4) developed this method for a high moisture (30 to 50 percent) dehydro peach which has high quality. Dehydro peach makes an excellent snack item to be eaten out of hand or to incorporate in such products as pies, cakes, or candy centers.

VI. *Peach pickles.*—This product makes use of cling and semicling peaches. The peaches are obtained from the fresh market packing sheds, sized from 1 5/8 to 2 inches in diameter. Our work on this product was twofold, to develop a continuous cook and to develop a colored peach pickle.

VII. *Osmotic dehydration of fruits.*—A method of partial dehydration of fruits by osmosis in sugar or syrup has been developed by Ponting and coworkers (6) at the Western Utilization Research and Development Division. The fruit is reduced to about 50 percent of its original weight by this process, after which it is drained and either frozen or dried. Much interest has been shown in their process and USDA has released information on this product.

VIII. Other peach products in our area are frozen peaches for ice cream and preserves. There are plants in Georgia, South Carolina, and North Carolina in this phase of peach processing. There are plants in North Carolina and Arkansas for puree for baby food. Our work originally started with Tennessee Valley Authority in this area, the first portion control frozen peaches were packed in 1932 in Georgia, but home freezers were not in every home at that time. It was several years later before the industry came of age as we know it today.

Pollution is a problem in the processing industry, but Secretary of Agriculture Hardin in an address to the Southern Agriculture Workers in Memphis, February 1970, placed it on the top of the list of jobs we must get finished. Since every operation except one discussed in this paper used lye in its operation, it would be a remiss if I did not briefly discuss the work at the Western Regional Laboratory on Dry Lye Peeling. This procedure was developed for peeling white potatoes. In a personal communication with Feinberg[2], the following information was obtained. Peeling without use of water eliminates liquid wastes resulting from conventional lye peeling and the problem of disposal of these liquid wastes. Jack Ralls of NCA's Western Regional Laboratory reported that "Tests on dry lye peeling of peaches have been so successful we wonder why we haven't done it before."

In the dry lye peeling process, the peaches are sprayed or dipped in a lye solution, then exposed to heat in an infrared oven. Part of the skin flakes off after this treatment; the rest of the skin is rubbed off mechanically by small diameter rubber disc mounted on rollers.

Steps in Canning Peaches

1. Receiving and grading. Unripe fruit may be held in field containers for further ripening.
2. Dumping field boxes onto belt or pallet boxes into tank of water. Water absorbs the shock and washes the fruit.
3. Grading and sizing on rollers.
4. Pitting by machine or hand.
5. Regrading, removing pits, and turning the peach halves with peel up.
6. Lye peeling by spraying or immersing, followed by brief holding to allow lye to react with peel.
7. Washing with spray or in rotary washer, and turning the halves with seed side up.
8. Rewashing with spray or vibrator washer.
9. Grading and inspecting.
10. Sizing into three grades.

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[2] Feinberg, Bernard. Personal communication. Western Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, Albany, Calif. 1970.

11. Adding 4 ounces of 65° Brix syrup at 200° F.
12. Adding 19 ounces of fruit per can.
13. Adding 8 ounces of hot water, or enough to fill can.
14. Sealing under vacuum.
15. Cooking cans in continuous cooker or in retorts at 212° F. for 45 minutes, or to an internal temperature of 190°.
16. Cooling to 90° to 100° F. in countercurrent water.
17. Labeling and casing.
18. Warehousing and shipping.

Steps in Preparing Clear Peach Juice Concentrate

1. Receiving and grading fruit to remove overripe, green or rotten fruit; unripe fruit may be held for further ripening.
2. Washing and roller grading.
3. Pulping to remove soft portion from seed, using 1/4" screen. The system is closed from this point and kept under blanket of nitrogen.
4. Adding pectinase enzyme to clarify juice.
5. Holding in tank for 1 hour to allow enzyme to act; add filter aid.
6. Pneumatic press using 80 pounds pressure.
7. Vibrator screen to remove pulp.
8. Centrifuge for clarifying the juice, installed so it can be backwashed to remove sludge.
9. Heat exchanger to raise temperature to 150° F.
10. Multistage evaporator to concentrate juice to 64° Brix.
11. Filled into 55-gallon barrels. The product can be packed with SO_2 and kept refrigerated, or it may be packed asceptically and held without refrigeration.

Steps in Preparing a High Quality Product-Refrigerated Fresh Sliced Peach

1. Use peaches harvested in the ripe, but in a firm stage so they may be hauled and handled with a minimum of bruising, and can be peeled, pitted, sliced, and packed without being more than slightly ragged.

2. Heat peaches in water at 130° F. for 2 minutes then hydrocool to 50° at the seed, when they are received. This reduces surface microorganisms and firms the fruit slightly. (This step is recommended, but optional.)

3. Grade fruit for size, ripeness, and defects. Use incline grader (or other) which gently rolls peaches for hand removal of unsuitable fruit. Prime ripe fruit, having full color and flavor, is processed immediately or may be held under refrigeration; underripe fruit is held to ripen at room temperature or in controlled rooms. Overripe (soft) fruit should be avoided since slices become excessively ragged and soft, resulting in a turbid syrup with a large amount of fruit fragments and a short shelf life. Uniform, medium size fruit of one degree of ripeness is preferred, since a much more attractive pack is obtained when all the slices are about the same size, shape, and color.

4. Peel with boiling lye solution. Use immersion for whole peaches, and spray for halves with pit cup down. The lye solution should be of sufficient strength (usually about 5 percent), and hot enough (above 212° F.) to loosen the peel within about 20 seconds. If the lye solution is too weak or too cold, the fruit will have a rough surface or be incompletely peeled. On the other hand, if the lye is too strong, overpeeling will result, and the unnecessary lye used will add to cost of production.

5. Wash rapidly with ample water to remove loosened peel and lye. Use rotary washer for whole fruit and spray washer for pitted halves.

6. Neutralize lye and add preservatives. Peeled fruit is dipped in or sprayed with water containing citric acid (0.5 percent), ascorbic acid (0.15 percent), and sodium benzoate

(0.25 percent). This may be accomplished with a dip tank or recirculating spray. The treatment will neutralize traces of lye which accelerate browning, reduce oxidative deterioration of flavor and retard microbial spoilage. This step is very important for high quality and good shelf life.

7. Slice peaches off the seed by hand or machine-slice pitted halves. There are advantages and disadvantages for both hand slicing and machine slicing. Advantages in favor of hand slicing include: (1) peaches may be graded, trimmed, pitted, sliced and filled in jars in a single step, (2) uniform slices can be made lengthwise of the peach, (3) a minimum of waste results from regular shape and sizes. Disadvantages of hand slicing are: (1) the large amount of labor required for volume production and (2) the skill necessary for efficient operation.

   Some advantages of machine slicing are: (1) a more mechanized production line and (2) a smaller labor requirement. Some disadvantages of machine slicing are (1) all slices are not made the same direction of the fruit giving many slivers and irregular pieces, and (2) employees are needed to feed and handle the peaches being sliced and filled.

8. Combine sugar and preservatives with slices. There are two methods of doing this: (1) use any dry sugar which is well-suited to hand packing operation; (2) use liquid sugar, which can be adapted to an automated slicing and filling line.

   In the dry sugar method, use the following formula:

sliced peaches	18 pounds
sugar	2.25 pounds
ascorbic acid	0.025 pounds (11.50 grams)
sodium benzoate	0.001 pounds (4.58 grams)

   Mix the sugar, ascorbic acid, and sodium benzoate together and coat the peach slices by gentle mixing. Enough juice will be drawn out of the peaches to almost cover the slices in jars. Yield about 12 to 26 oz. jars.

   In the liquid sugar method the 26 oz.--straight wall jars are presyruped with 4.3 ounces of liquid sugar containing 0.896 percent ascorbic acid, and 0.349 percent sodium benzoate. Then the slices are placed in jars. If available, use vacuum or steam jet closure.

   A fruit-sugar ratio of around 8:1 was found to give a product with good appearance, eating qualities, and shelf life. The cut out Brix average 21.6° and ranged from 19° to 22°; drained weight average 17.7 ounces for 31 varieties.

9. Chill jars rapidly to 34° to 36° without delay. This is very necessary to retard spoilage until the preservatives have time to penetrate into the fruit. This may be done by spraying the jars with recirculated ice water or by running them through a cooling tunnel with counter flow ice water. About 30 minutes' cooling with ice water was required to lower the center temperature to a safe maximum level.

10. Dry off cooling water rapidly by passing jars under a high velocity fan; case.

11. Store the cases at 30° to 32° F. in an inverted position. It is essential that low temperature (32° or lower) be maintained during warehousing. This maintains marketable shelf life for about 16 to 20 weeks.

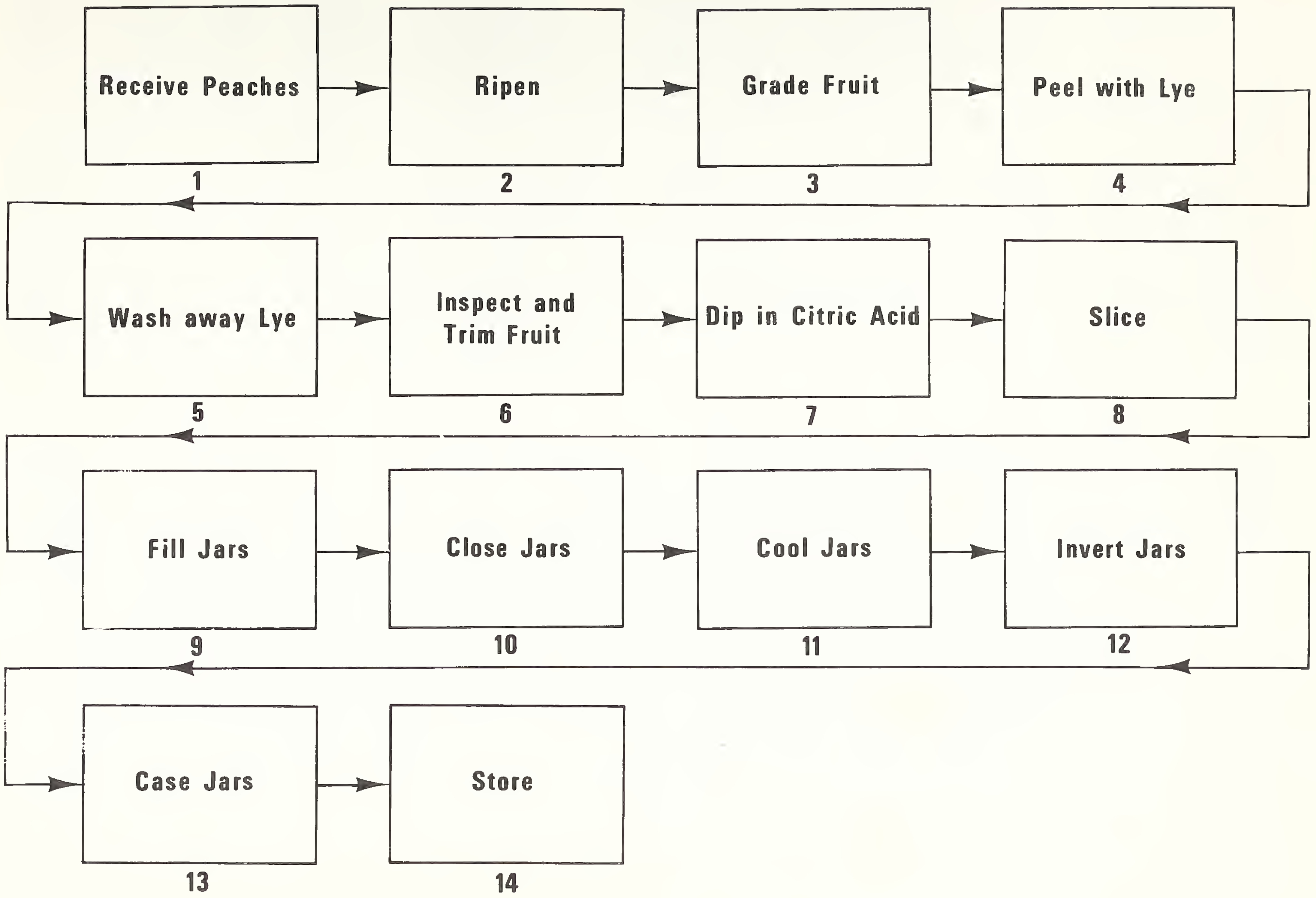
Since refrigerated fresh-sliced peaches are neither heat processed nor frozen, a rigid sanitary program must be followed. The slicing and filling areas must be thoroughly cleaned and chlorinated at least every 2 hours to avoid microbial buildup on equipment and machinery.

Steps in Preparing a High Quality Peach Drink Base

1. Use fully ripe, soft peaches of the "melting flesh" type. Both cling and freeseed varieties are suitable. They may be orchard run, or overripe pickouts from packing sheds, and canning or freezing operations.

2. Grade for ripeness and freedom from objectionable defects. Select soft ripe fruit which is free of rot and other spoilage, and insect infestation. Use incline grader (or

FLOW SHEET FOR REFRIGERATED FRESH SLICED PEACHES



other) that gently rolls peaches for hand removal of unsuitable fruit. Ripe fruit is processed or may be held under refrigeration; unripe fruit is held to ripen at prevailing conditions or in controlled ripening rooms.

3. Wash peaches with water containing a "surfactant" to aid peeling and reduce the amount of lye required for peeling, use immersion or recirculating spray.

4. Peel with boiling lye solution. Use immersion or immersion-spray peeler for whole peaches, and a cup-down spray peeler for pitted halves. The lye solution should be of sufficient strength (less than 5 percent), and hot enough (above 212° F.) to loosen the peel within about 20 seconds. Allow an additional 30 to 60 seconds oxidation period for the lye to dissolve the skin layer. If the lye solution is too weak or too cold, the fruit will be incompletely peeled or have a pitted surface. If the lye solution is too strong, overpeeling will result in reduced yield, and unnecessary use of lye.

   CAUTION: When peaches that have been stored under refrigeration are to be lye-peeled, they should be allowed to warm-up thoroughly before peeling, otherwise peeling will be poor and peeled fruit will oxidize rapidly.

5. Wash rapidly and completely using ample water to remove loosened peel and lye. Use rotary washer for whole fruit and spray washer for pitted halves. Brush washers are not recommended since they tear-up soft fruit and greatly reduce yield.

6. Inspect peeled fruit, separating out that which is incompletely peeled, green, discolored, rotten or otherwise defective. This step is very necessary for a high quality product. If fruits with moldy or rotten spots are allowed to go into the product, it will result in a finished product having a high mold count and poor flavor.

7. Heat fruit (whole or halves) in a continuous stainless steel thermoscrew cooker to an average temperature of 145° to 150° F. Heating softens the fruit and aids in pulping, retards oxidation of color and flavor, and stabilizes the cloud in the drink base. This is accomplished in about 2 minutes when 20 pounds' steam pressure is maintained in the jacket around the thermoscrew. More rapid and efficient heating is attained if a prebreaker is installed at the entrance end of the thermoscrew to break up the peaches.

8. Pulp by passing through a pulper with a 1/4 inch perforated screen to remove and separate soft flesh from seed and unripe portions. The pulper should run at moderate speed (about 1,000 r.p.m.) and be adjusted to hold in the peaches for sufficient time for complete removal of soft fruit. Where the pulper is failing to completely remove the fruit from the seed, the fruit is too hard or the pulper is not properly adjusted.

9. Finish the pulp by passing it through a finisher with stainless steel screen having 0.033 inch or smaller, to 0.024 inch perforations. This reduces the pulp to liquid and removes the large fibers. The finisher should be run at moderate speed (1000 to 1200 r.p.m.) to more thoroughly extract the pulp and minimize the amount of air incorporated into the liquid.

10. Collect the liquid from the finisher into a surge tank and meter in ascorbic acid (0.14 percent) to prevent oxidation during subsequent processing. For efficient use of ascorbic acid, the metering pump may be operated through a float switch in the surge tank.

11. Accumulate in tanks for blending and standardizing. Blending and standardizing are necessary so that processors using the drink base in finished items may be furnished a consistently uniform product. Several varieties of early-, mid-, and late-season maturity have different quality characteristics and require blending for the production of a uniform drink base. The early varieties usually have pale color and low soluble solids, while the late have more intense color and higher soluble solids.

    Blending may be accomplished in two general ways: (1) during regular processing season by mixing the desired proportions of late season base, which was carried over from the previous season for the specific purpose of blending; (2) following the regular season, as a separate processing operation. The first is recommended since it requires much less handling. After blending and standardizing, feed uniformly and without delay to the pasteurizer.

12. Flash pasteurize at 195° to 200° F., and flash cool at 35°. Plate type juice pasteurizers heated with hot water under pressure have been found very satisfactory and tubular juice chillers, cooled by ammonia refrigeration are also very satisfactory. Tubular pasteurizers may be used.

13. Fill into 55-gallon drums lined with 3-mil polyethylene bag for frozen storage. Smaller containers may be used if desired, that is, 30 pound metal cans, or fiber drums of convenient size. The product may be filled hot in No. 10 or smaller size cans, and handled as a hotpack pasteurized product. If this is done, then the cans are inverted after sealing and allowed a few minutes for sterilization of the lid before cooling.

Steps in Reprocessing Peach Drink Base Into Drinks

1. Receive peach drink base in 55-gallon drums or other large containers in frozen condition. It may be received in No. 10 or smaller cans as a nonrefrigerated item.

2. Store under refrigeration, when frozen base is to be held longer than 48 hours before processing. At least 48 hours thawing at prevailing temperatures are required for the base to thaw enough to be emptied from drums with an air pump. However, less thawing is needed when drums are emptied by hydraulic dumpers into a vat or tank having ice breakers.

3. Blend drink in stainless steel tanks. Use liquid sugar, acid, and other ingredients where possible and meter these into tanks, then add peach base. The tanks should be equipped with bottom and side agitators, both used for blending. During processing and filling the side agitator is cut off and the bottom one left on to keep insoluble solids (pulp) uniformly mixed. The bottom agitator more effectively keeps pulp mixed and incorporates less air into drinks.

4. Flash pasteurize at 200° F. using plate-type juice pasteurizer. The pasteurizer may be heated with hot water or steam.

5. Homogenize at 2,000 to 2,500 p.s.i. while hot, using juice homogenizer. Homogenization stabilizes the product by thoroughly mixing the gum stabilizer and prevents separation of liquid and insoluble solids during storage and merchandizing.

6. Fill hot (195° F.) into preheated glass or tin containers, use gravity flow or gravity-vacuum assist fillers. Peach drink foams during filling, however, no problem of "slack" fill has been encountered with these types of fillers.

NOTE: Positive action metering type pumps are suggested to regulate flow from blending tanks through the pasteurizer and homogenizer to the filler.

7. Close glass containers with steam jet capper mainly to sterilize caps. Closed tin cans may be inverted to sterilize tops.

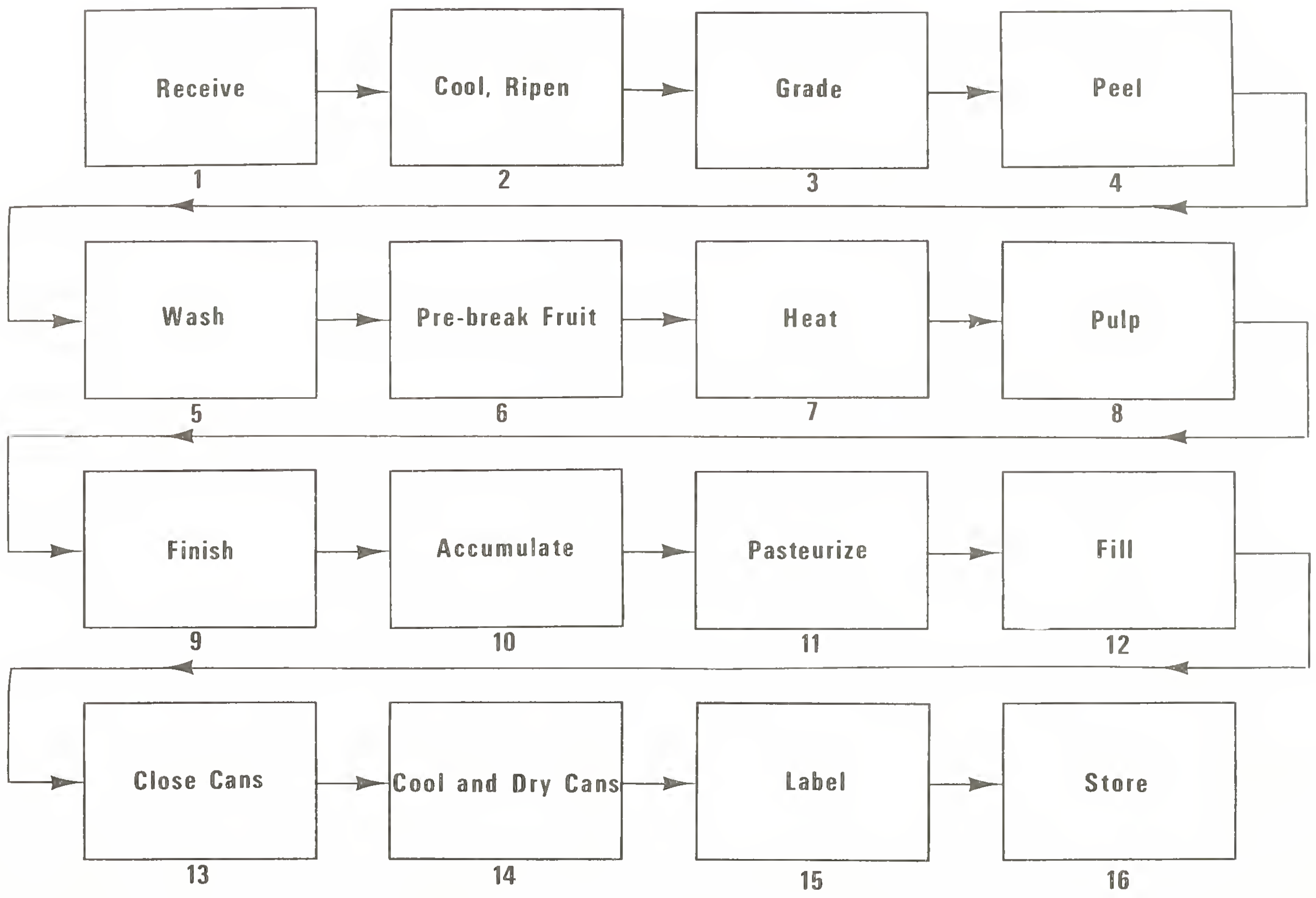
8. Cool containers to below 100° F. with water. Cooling may be with sprays or in counter flow canal. When cooling glass packed drink, be sure that the water at the infeed end (where product enters) cooler is not more than 60° colder than the filling temperature of the product. This will prevent thermal breakage. However, with tin cans this is not a critical factor.

9. Dry cooling water from containers with warm air. This will reduce water spotting on glass and rusting of tin cans.

10. Label, case, and store in cool dry place.

The steps for making peach-orange drink are essentially the same as for peach juice drink, except it was sterilized by the "Mallory Process."

FLOW SHEET FOR PEACH DRINK BASE



Formula for Peach Juice Drink

	Pounds	*Ounces*
Peach drink base (4 drums or 200 gal.)	1720	
Water (214 gal.)	1775	
Invert syrup 50 percent (76.5° Brix)	531	
Malic acid (crystal)	5	12
Stabilizer (vegetable gum)	4	5
Color (yellow No. 6)		1.15

NOTE: Liquid sucrose (66.3° Brix) may be substituted for invert syrup by using 611.5 pounds and adjusting the water to (205 gal.) 1,702 pounds. If granulated sugar is used, 406 pounds are required with (229.5 gal) 1,905 pounds water.

Formula for Peach-Orange Drink

Peach drink base (4 drums or 200 gal.)	1720 pounds
Orange juice concentrate, 42° Brix (16.5 gal.)	191 pounds
Water (375.5 gal.)	3118 pounds
Invert syrup, 50 percent (76.5° Brix)	588 pounds
Malic acid (crystal)	6 pounds 6 ounces
Orange oil (small amount for flavor fortification)	

Flow Sheet for Flaking Process

The processing steps are shown in the following flow sheet. The initial steps, similar to those used in the peach drink process, are:

*select, soft-ripe peaches of edible quality as normally selected for preserves, frozen purees, and nectars; hold firm-ripe fruit until soft, discarding that which is green or has undesirable odor;

*peel by immersing in and spraying with 5 percent lye at 210° F. for 30 sec.;

*wash using very fine sprays and brush lightly with soft nylon brushes to remove peel;

*inspect and trim to remove bruised or decayed spots;

*prebreak the whole peaches and cook in a continuous thermoscrew for 2 minutes; and

*pulp with a Langsenkamp Model A pulper using 1/4 in. perforated screen and rod blades to remove the seed and unripe portions from the soft flesh.

Process Deviates

At this point the flake process deviates from that of preparing a peach drink. In a combination flake and drink plant the processing line can be split after the pulper with a portion going into each product.

The new additional processing steps for flake production are:

*comminute;

*incorporate additives for flavor and color enhancement;

*incorporate additives to improve drying operation;

*dehydrate on an atmospheric double drum dryer;

*blanket dry peach solids with dehumidified air as they are discharged from dryer;

*grind into flakes; and

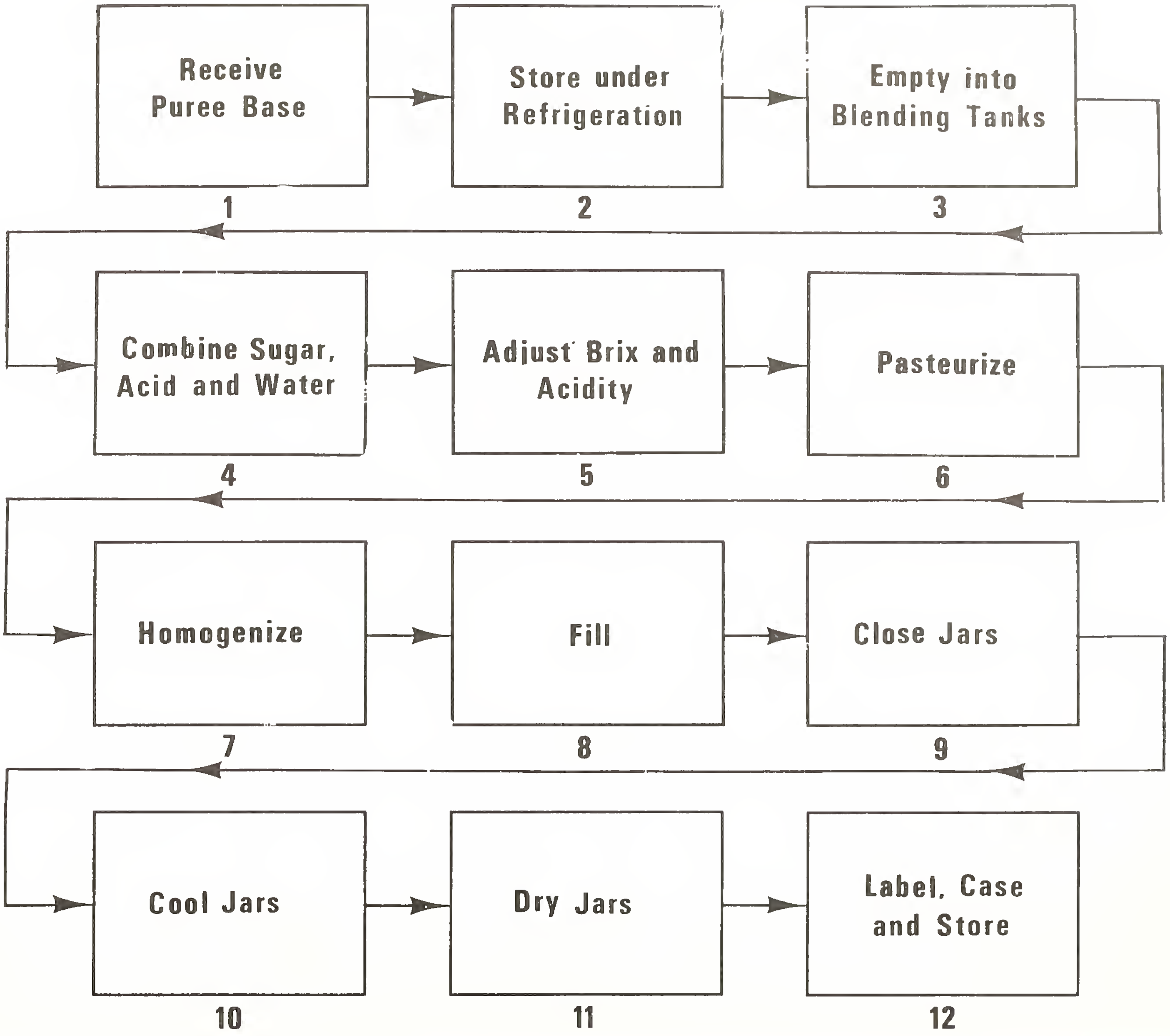
*package into suitable containers.

As indicated by the dashed line in process diagram, it is possible, when a processing plant makes puree bases for both drinks and flakes, to utilize some peach fiber normally discarded from drink line, by adding it to puree going into flake line. This does not degrade quality of peach flakes and actually facilities the drying operation.

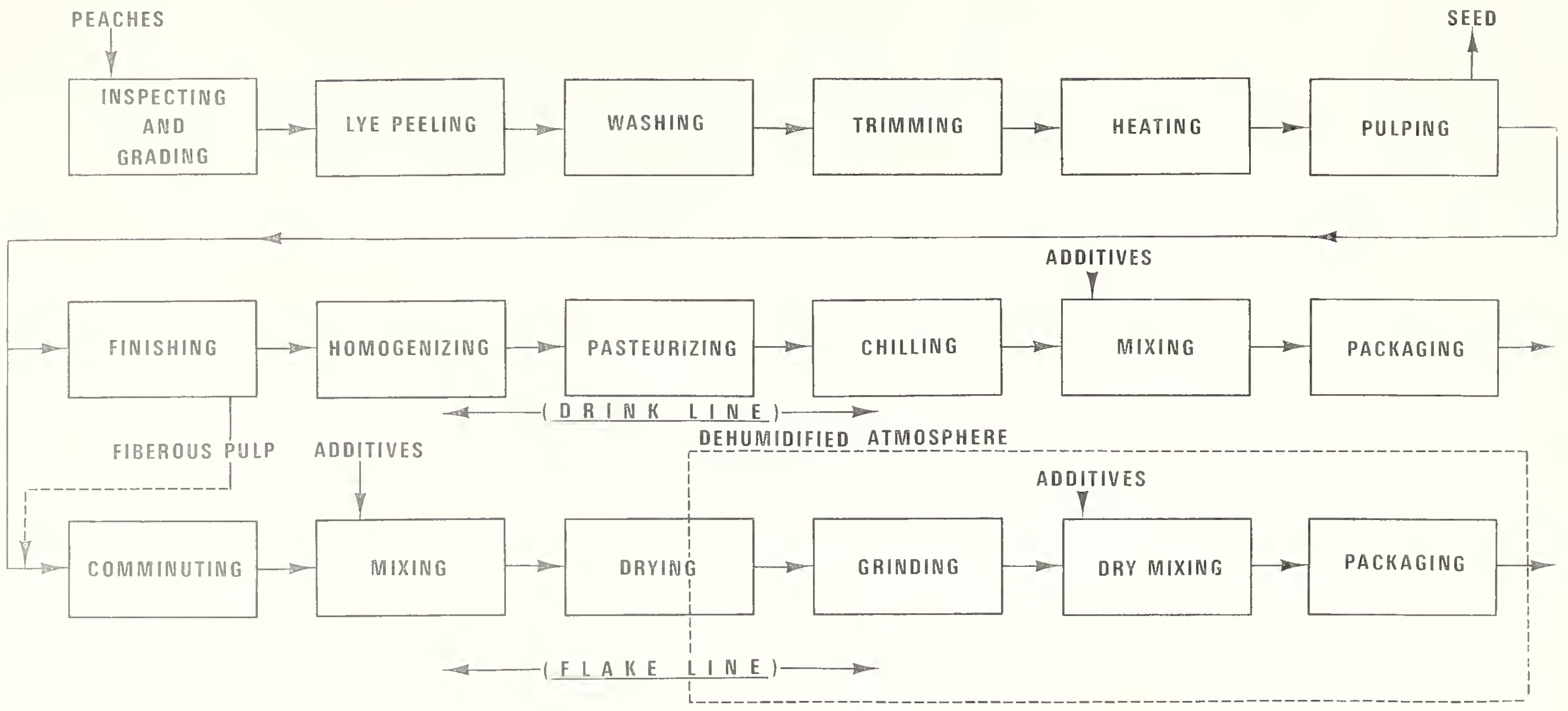
Steps in preparation of pasteurized, partially dehydrated peaches. Essentially the procedure consisted of the following:

1. Receiving fruit, and cooling if held overnight.
2. Ripening (when necessary) to uniform color and texture.
3. Grading for size, ripeness and defects (firm ripe fruit is best; soft fruit becomes flabby; and unripe spots shown up green).
4. Peeling by immersing in 5 percent lye at 210° F. for about 30 seconds.
5. Washing with rotary or spray washer to remove lye and loose peel.

FLOW SHEET FOR PEACH DRINK



FLOW SHEET FOR PEACH PUREE BASE AND DRUM DRIED FLAKES



6. Brushing lightly, trimming and washing.
7. Dipping in 0.5 percent citric acid to neutralize lye residue and prevent browning.
8. Halving and deseeding by machine or hand.
9. Vacuumizing, 27 inches for 2 minutes, releasing vacuum and repeat. Hold fruit in solution of 30 percent sucrose, 0 to 1.5 percent sodium busulfite and 0.1 percent potassium sorbate at 120° F. for 5 to 10 minutes.
10. Draining excess liquid and centrifuging at low speed.
11. Dehydrating to about 35 percent moisture at 120° F., with air circulating at 160 cu. ft. per minute.
12. Cooling the dehydrated fruit in a tight container.
13. Equilibrating at 32° to 50° F. to uniform moisture content, requiring about 15 to 30 days.
14. Packaging in Saran or other heat-sealable moisture-proof bags.
15. Pasteurizing 30 minutes at 155° F.
16. Storing in cool, dry place.

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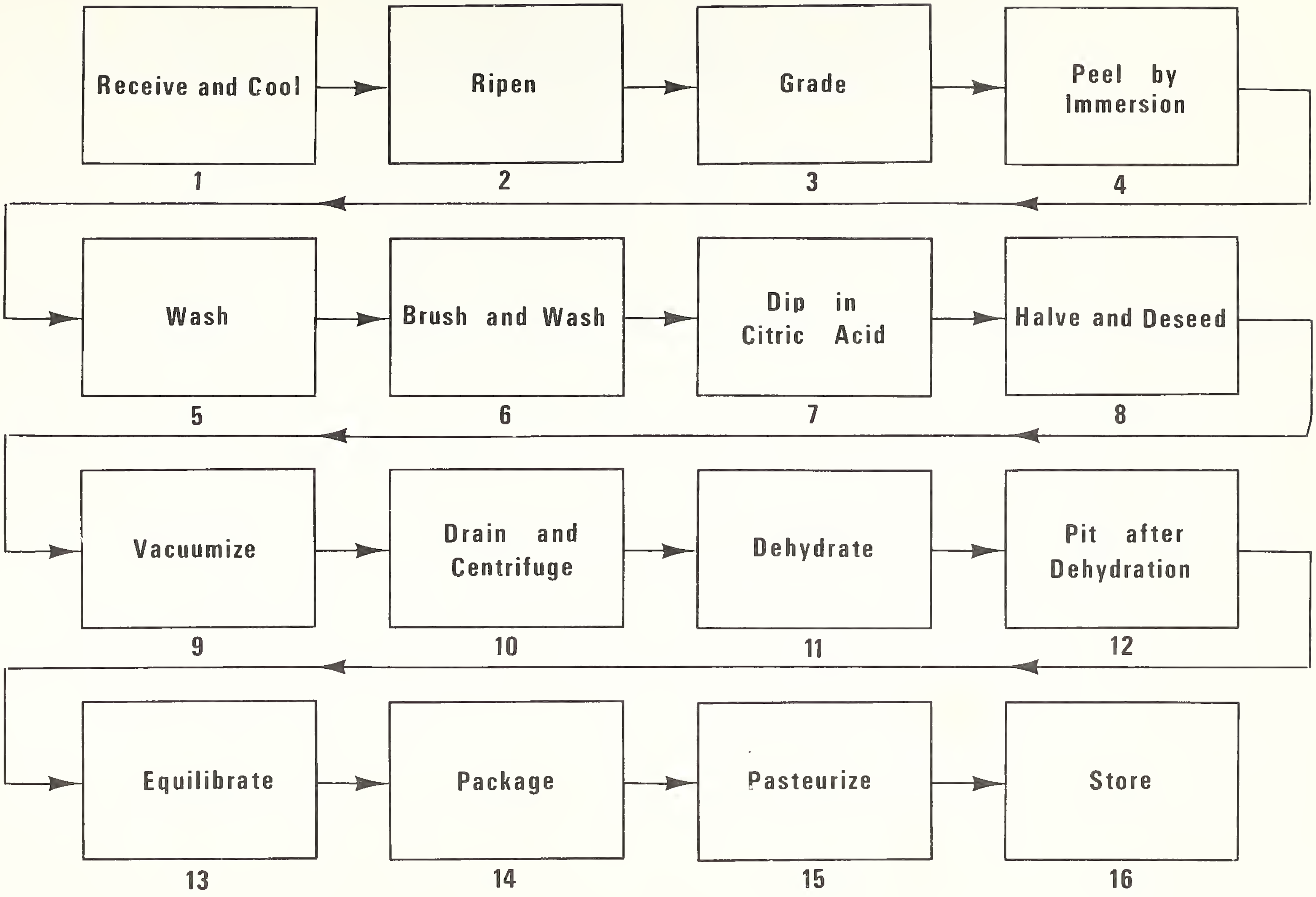
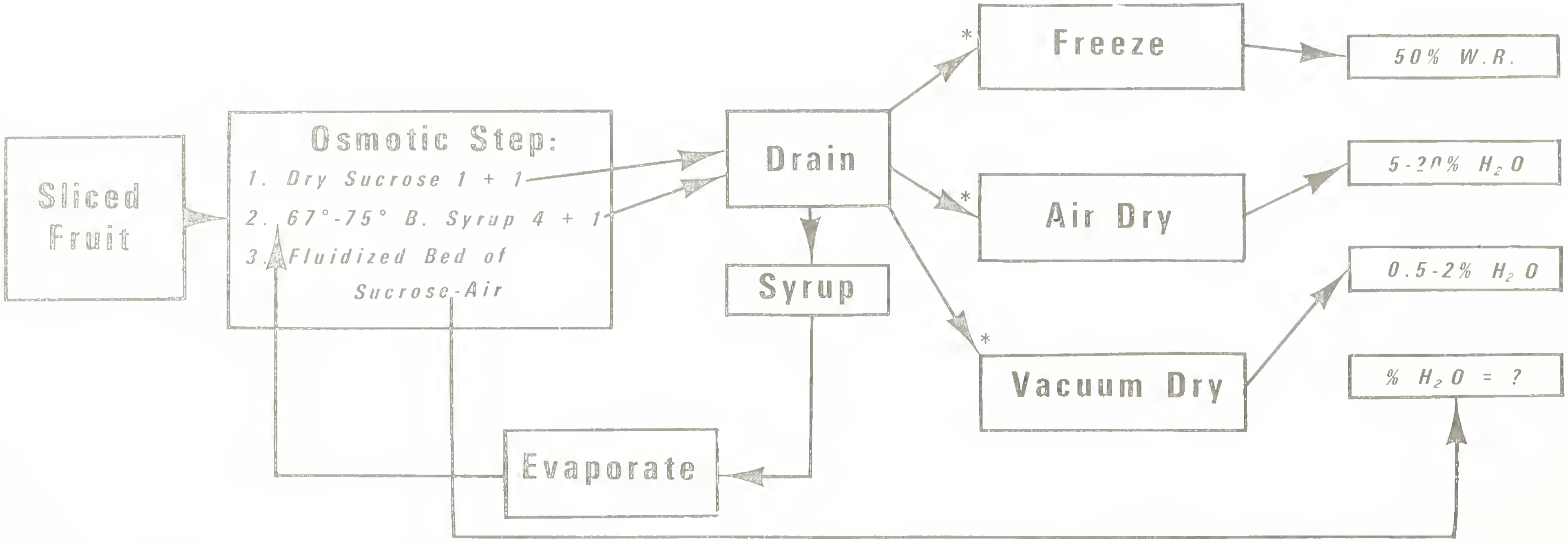
FLOW SHEET FOR PARTIALLY DEHYDRATED PEACHES



Flow Sheet for Osmotic Dehydration of Fruit



* A blanching step can be inserted here for fruit which must be blanched before use (e.g. pie fruit).

THE LOUISIANA STATE UNIVERSITY INFRARED PREHEAT RICE DRIER

by

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(Presented by M. D. Faulkner)

INTRODUCTION

Conventional methods of grain drying employ the heat contained in the drying air to supply energy for water evaporation, or mass transfer of water vapor from the grain to the drying air stream. Where heated air is used, as in most driers, the wet and dry bulb temperatures are increased by addition of heat. This process decreases the relative humidity of the air and increases its capacity to hold water.

During the drying process of transfer of moisture from grain to air, the dry bulb temperature is lowered while the wet bulb temperature remains approximately constant.

This moisture or mass transfer continues, under extremely good drying conditions, until near ambient dry bulb temperatures are reached. However, if the grain is heated before conventional drying and the vapor pressure within the grain is increased, it is reasonable to assume that the wet bulb temperature of the drying air would be increased by a process similar to injecting steam into air. This process should logically increase the efficiency of the drying air and reduce the total time required to dry rice or other grain.

Using a rational approach of reducing total drying time, the problem becomes simply one of applying sufficient heat to the grain to attain desirable rates of drying. Practically, the problem is one of applying heat to the grain to attain desirable drying rates and to maintain quality during the process.

The basic assumption, when the work began on this project, was that heat applied uniformly throughout the grain would tend to create less breakage than heat applied at the surface of the grain. On the basis of this assumption, the decision was made to begin with infrared as the preheat source because of its ability to penetrate the grain and tend to heat more uniformly.

Schroeder and Roseberg[1] had demonstrated that rice could be subjected to infrared radiation for relatively long periods of time and maintain quality. This work supported the belief that the approach was sound in using infrared, as the preheat source for a new drying system.

From exploratory work, it was evident that we could indeed increase drying rate by increasing the grain temperature before exposure to drying conditions. Table 1 shows the results obtained from preheating rice in closed containers before drying.

With a strong belief that quality could be maintained and drying time reduced, the project started with the primary objective being one of determining suitable equipment and procedures to utilize infrared as a preheat source for rice drying.

PROCEDURE AND EQUIPMENT

Infrared heaters.—From a spectrogram of rough rice, it was determined that very little infrared is absorbed below wavelengths of approximately 2.75 microns. For longer wavelengths, absorption is somewhat erratic up to slightly over 5 microns, and fairly good over 6 microns. However, good absorptions occur at about 3.25 microns and at 4 microns.

Most ceramic infrared radiators operating at 1,600° to 1,700° F. show peak radiators at

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[1] Schroeder, Harry W., and Roseberg, David W., Drying rough rice with infrared radiation. Rice Jour., 62(6): 16. 1959.

Table 1.—*Moisture removal from rice preheated and rice at ambient temperatures*

Drying air temperature	Moisture content	Sample temperature at start of drying	Average moisture removed[1]
°F.	*Pct. wt. bases*	*°F.*	*Pounds per minute*
120	17.12	120	0.0060
120	17.69	ambient	0.0050
180	17.44	120	0.0160
180	16.91	ambient	0.0146
220	17.61	120	0.0206
220	16.99	ambient	0.0180

[1] From 4 pounds of rice; using air velocities of 100 ft./min.

approximately 2.4 to 2.5 microns, but also show high radiation at 3 to 4 microns. Consequently, the decision was made to use ceramic radiation fired by natural gas due to the availability of equipment and of the gas. Figure 1 shows a spectrogram of rough rice with a radiant intensity graph for the heaters selected, superimposed.

Calculations of time required to heat rice grain.—The rate of heating may be illustrated by calculating the time required to produce a specific temperature rise when a single grain of rice falls between two infinitely long parallel plates at some specific high temperature.

The net heat exchange between the radiating plates and the grain is:

$$Q\ 1 \qquad 2 = A_1\ F_{1/2}\ \sigma(T^4 - T_2{}^4)$$

and the net increase in internal energy of the grain is:

$$Q_{INT} = Cpv\ \frac{dT}{dT}$$

Equating these two expressions and solving for t, we obtain

$$= \frac{CpV}{A_1\ F_{1-2}\ \sigma}\left[\frac{1}{4T_2\ \ 3}\left(2\,\mathrm{Tan}^{-1}\frac{T - 1n}{T_2}\left|\frac{T - T_2}{T + T_2}\right|\right.\right]_{T_O}^{T}$$

Where:

c = specific heat of grain
p = density of grain
v = volume of grain
o = Stefan-Boltzman constant
A_1 = area of grain exposed to radiation
F_{1-2} = Shape factor depending upon shape and emissivity of surfaces 1 and 2. For this case F_{1-2} = , the emissivity of the grain (assuming = 1 and rice grain as a gray body)
T_O = initial temperature of grain absolute
T = temperature of grain at any time t, degrees absolute
T_2 = temperature of plates, degrees absolute
t = time required to produce temperature change from T_O to T_1 and will be a function of the average velocity of the grain falling between the plates.

Solving this equation for the time required to produce a change in temperature of a grain of rice from 80° to 130° F. when the parallel plates are at 1,600°, we find that 0.43 second is required for this 50° rise. The constants used for this solution are: $c = 0.38$ B.t.u./lb., $p = 88.0$ lb./ft.^{3}, $v = 5.8 \times 10^{-7}$ ft.^{3}/grain, $A_1 = 3.82 \times 10^{-4}$ ft.^{2}, $F_{1-2} = 0.5$.

The above solution assumes a small gray body (rice grain) in black surroundings (infinite parallel plates).

By use of a high speed camera and strobe light, the approximate acceleration of a rice grain in free fall in still air was determined to be 18.72 ft./sec.^{2}. The distance traveled in 0.43 second would be 1.72 ft. To provide flexibility in the system and account for peripheral losses, heaters 5-feet high were selected. Using acceleration of 18.72 ft./sec.^{2}, the time required for a rice grain to fall 5 feet would be 0.73 second. A retention screen was provided for the rice which could increase time of fall to 5 feet of an estimated 1 second.

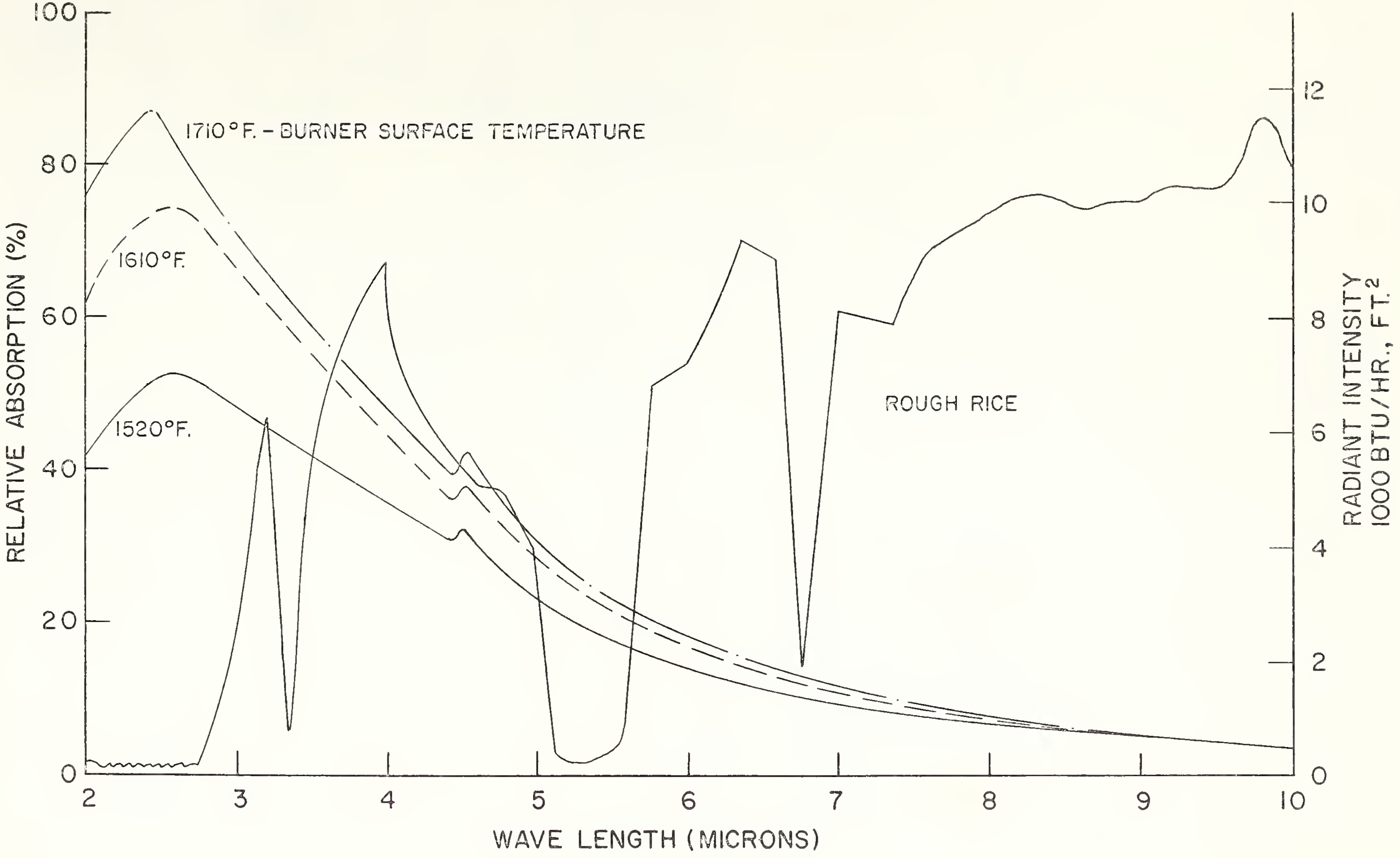


FIGURE 1 - SPECTROGRAM FOR ROUGH RICE AND RADIANT INTENSITY FOR INFRARED HEATERS.

Table 2.- *Temperature gains in rough rice from exposure to infrared radiation at 1,600°F., surface temperature of radiation, for about 1 second*

Moisture content	Initial temperature	Final temperature	Temperature gain
Pct.	*°F.*	*°F.*	*°F.*
12.30	30	127	47
13.62	56	100	44
14.58	53	106	53
17.31	78	124	46
20.00	51	97	46

Table 2 shows temperature gains in rough rice from exposure to infrared for about 1 second. The conditions for determining temperature gain shown in table 2 was at heater spacings of 14.5 inches. Later determinations indicated that closer heater spacings were more desirable. At 4.5-inch spacing, temperature gains of approximately 100° F. could be attained in 1 second for rice quantities up to 500 pounds per hour per inch of width of the heaters, operating at about 1,600° to 1,700°.

For the reasons indicated earlier, the decision was made to use ceramic infrared heaters fired by natural gas. The heaters selected were Number 126 IG manufactured by Eclipse Fuel Engineering Company, Rockford, Ill. The radiating surface of these heaters is about 0.5 ft.^{2}, and operate at maximum temperatures of 1,700° F. Radiant intensity of these heaters is shown in figure 1.

Calculations of heater output was by use of the Stefan-Boltzman law, i.e.:

$p = \sigma AT^4 e = \text{B.t.u./hr./}^\circ\text{R}^4$
σ = Stefan-Boltzman constant
$= 0.172 \times 10^{-8}$
A = area of heaters = 0.5 ft.^{2}/heater
T = temperature of heater = 1,700° F
= 2,160° R
e = emissivity of heaters
= 0.90
$P = (0.172 \times 10^{-8})\,(0.5\text{ ft.}^2)\,(2{,}160^\circ\text{ R})^4\,(0.90)$
= 16,848 B.t.u./hr./heater
= 33,696 B.t.u./hr./ft.^{2}

For convenience, a system was designed to heat 16,000 pounds of rough rice per hour for drying. The desired temperature gain in the rice was to be 100° F. The approximate heat required to accomplish this gain would be:

$Q = c\,(T_2 - T_1)\,W$
Q = B.t.u./hr.
c - specific heat of rough rice
= 0.38 B.t.u./lb. -° F,
T_2 = final grain temperature
T_1 = initial grain temperature

$T_2 - T_1$ = 100°F.
W = 16,000 lb./hr.
Q = 608,000 B.T.U./hr.

Utilizing the output of the heaters selected, the decision was made to construct a preheat unit 3-feet wide and 5-feet high. This configuration would be in two facing banks of heaters each having 15 ft.^{2}, or a total of 30 ft.^{2}. From the heater output, calculations, the total heat output would be:

$P_t = (\text{B.t.u./hr./ft.}^2)\,(\text{ft.}^2)$
$= (33{,}696\text{ B.t.u./hr./ft.}^2)(30\text{ ft.}^2)$
= 1,010,880 B.t.u./hr.

The total maximum rated input to the heaters is 1,560,000 B.t.u./hr.

Drying considerations.—A series of experiments were conducted to determine drying time, discharge air conditions, and quality for preheating with infrared. Figures 2 and 3 show discharge air conditions for rice drying following preheating with infrared. Figure 2 is simply a skeleton psychrometric chart where the drying air was heated to 140° F. Equipment limitations were such that wet and dry bulb temperatures could not be taken earlier than 1 minute after drying started. Point 3 on the figure shows air conditions after drying had progressed for 1 minute. Point 4 on figure 2 was reached in

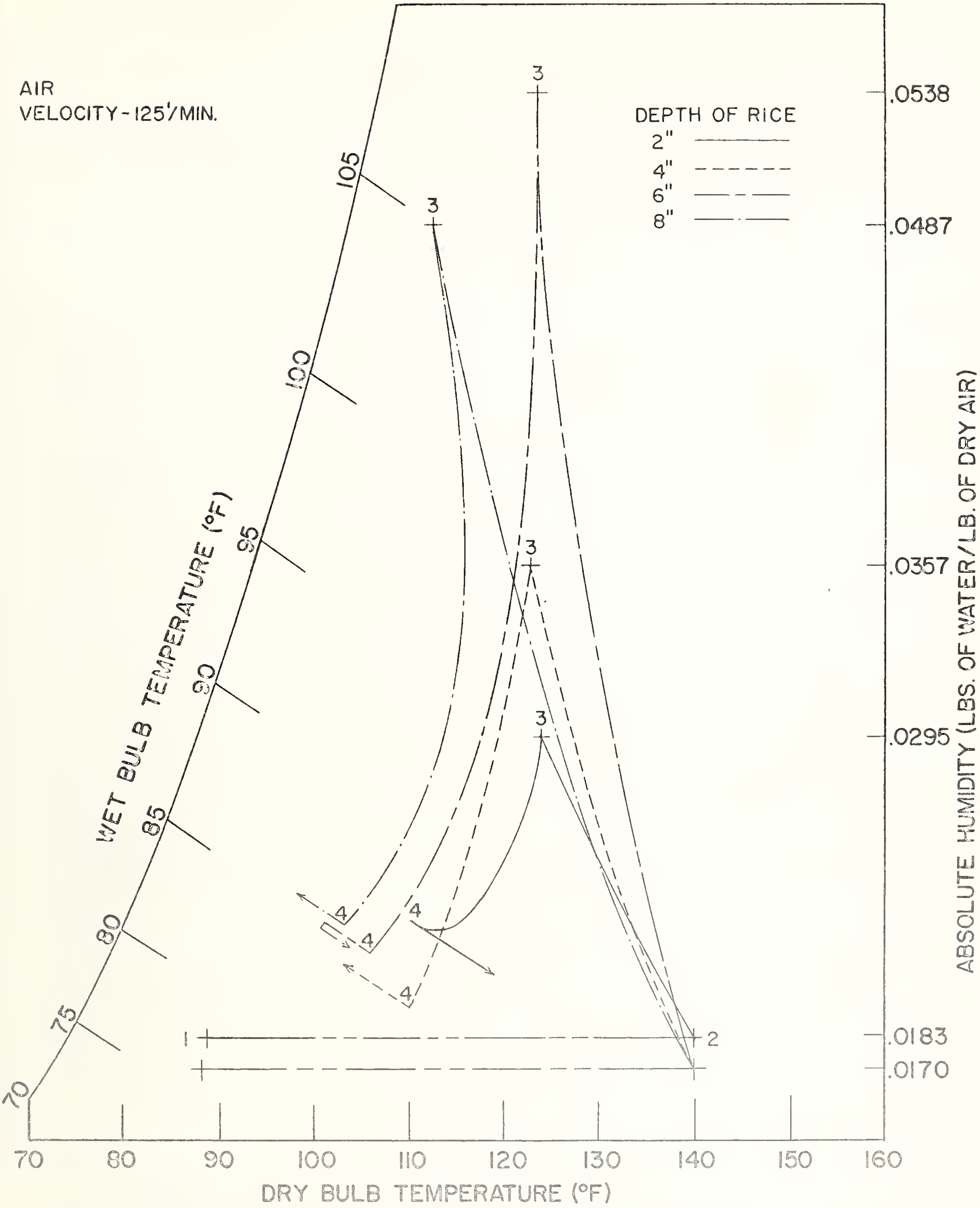
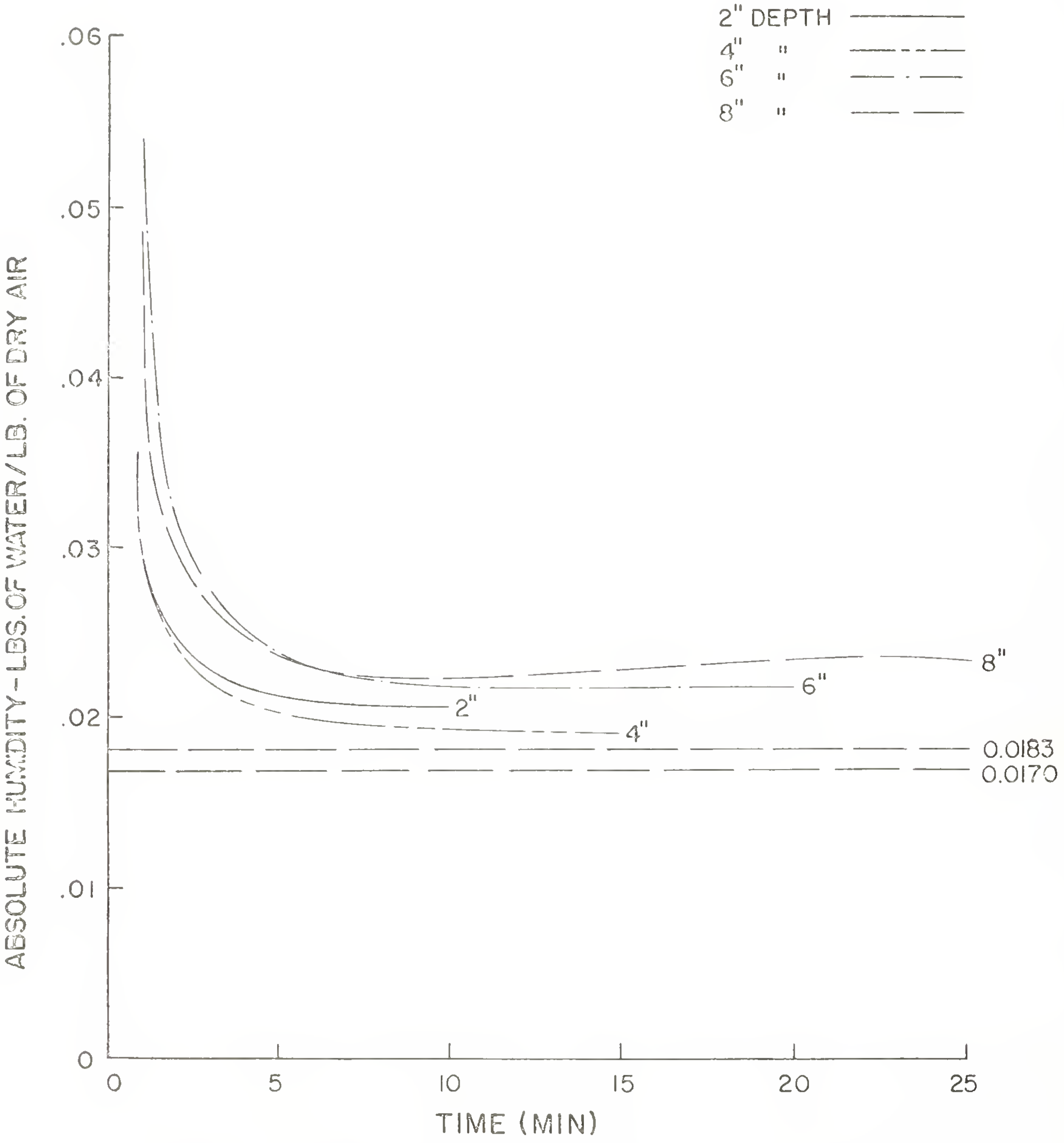


FIGURE 2 – DISCHARGE DRYING AIR CONDITIONS FROM PREHEATED RICE



AIR VELOCITY - 125'/MIN.
AIR TEMPERATURE - 140°F.
AMBIENT A.H. FOR 2" DEPTH - 0.017 LBS WATER/LB. DRY AIR
FOR 4",6",8" DEPTH - 0.0183 LBS. WATER/LB. DRY AIR

FIGURE 3 – ABSOLUTE HUMIDITY OF DISCHARGE DRYING AIR FROM RICE PREHEATED BY INFRARED

approximately 3 to 4 minutes, depending on grain depth. Figure 3 is a plot of absolute humidity of the discharge drying air. From figure 3, it is again evident that within 3 to 4 minutes, fairly stable discharge air conditions were reached and that little advantage could be gained by prolonging the drying period. From both figures 2 and 3, it is evident that the fastest drying occurred in the 2- and 4-inch rice depths, particularly in the 2-inch depths.

Table 3 summarizes one series of drying experiments which utilized preheating with infrared. From table 3, it is evident that two grain bed conditions were used experimentally to dry rice after preheating. The static bed utilized air velocities of 100 feet per minute. In the fluid bed air velocities sufficiently high to produce agitation of the grain were used. No attempt has been made to develop prototype equipment for fluid bed drying. Figure 4 shows some relative

Table 3.–*Summary of drying results obtained from drying rice preheated with infrared*

Drying air temperature	Drying interval	Bed condition	Total drying time	Moisture content	
°F.	*Min.*		*Min.*	*Pct.*	
				Initial	Final
Air dried check				Average 18.61	12.41
120	2	Static	18.0	do	12.07
120	2	Fluid	12.0	do	12.47
120	5	Static	29.5	do	11.98
120	5	Fluid	20.0	do	12.41
120	10	Static	35.0	do	12.15
120	10	Fluid	30.0	do	12.45
140	2	Static	15.0	do	12.55
140	2	Fluid	10.5	do	12.08
140	5	Static	19.0	do	12.53
140	5	Fluid	16.0	do	12.16
140	10	Static	30.0	do	11.72
140	10	Fluid	25.0	do	11.28
160	2	Static	12.75	do	12.43
160	2	Fluid	8.0	do	12.38
160	5	Static	20.0	do	12.37
160	5	Fluid	15.0	do	11.46
160	10	Static	25.0	do	11.44
160	10	Fluid	17.0	do	11.15
180	2	Static	11.0	do	12.62
180	2	Fluid	7.0	do	12.19
180	5	Static	15.0	do	11.54
180	5	Fluid	10.0	do	11.44
180	10	Static	25.0	do	9.99
180	10	Fluid	12.0	do	11.94
200	2	Static	7.5	do	12.63
200	2	Fluid	6.0	do	12.52
200	5	Static	15.0	do	11.24
200	5	Fluid	7.0	do	11.69
200	10	Static	20.0	do	10.39
200	10	Fluid	10.0	do	11.77

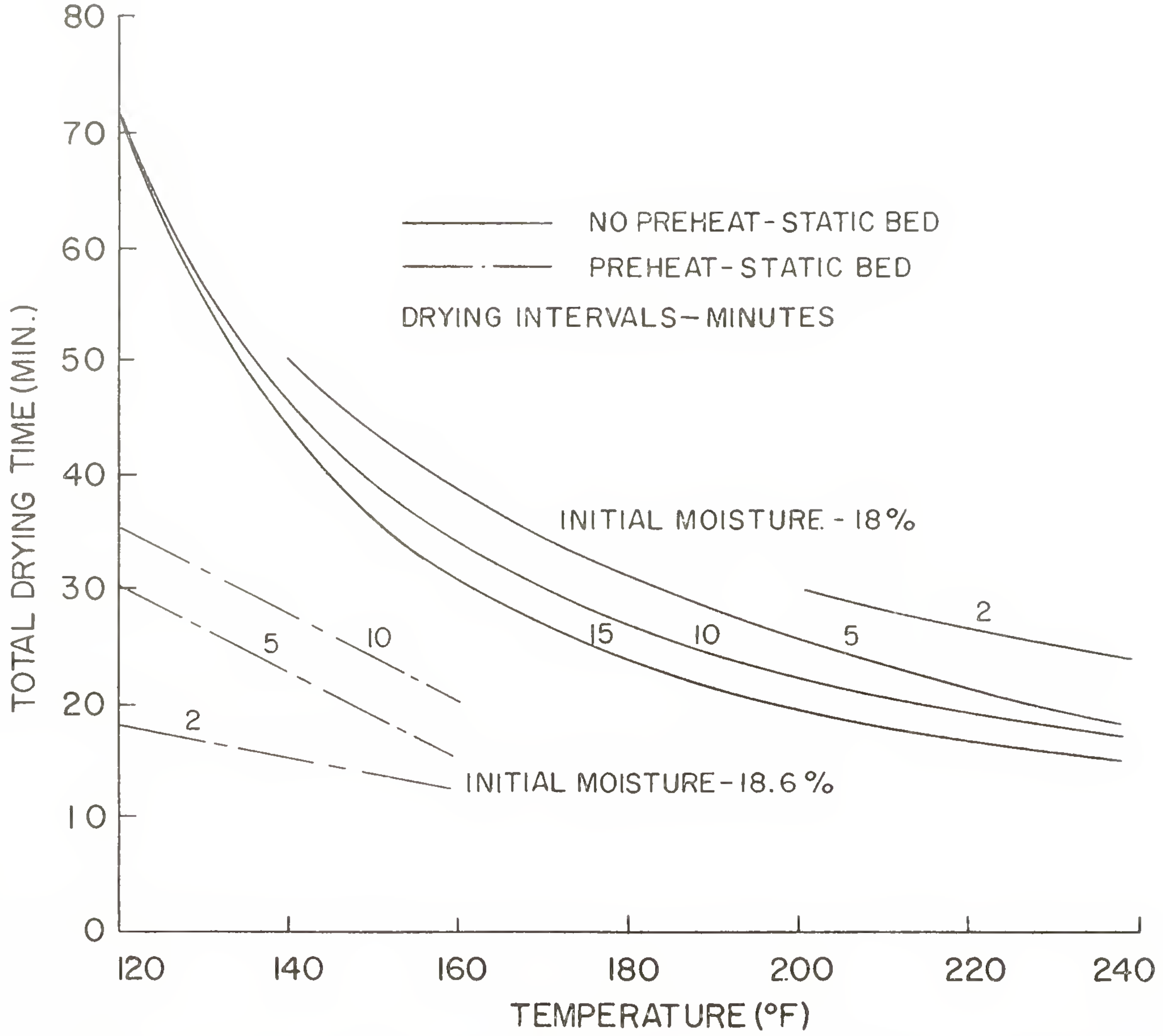


FIGURE 4 - EFFECTS OF DRYING CONDITIONS UPON TOTAL TIME FOR DRYING OF BLUEBONNET 50 ROUGH RICE.

Table 4.—*A summary of milling yields obtained from preheating Bluebonnet rice with infrared for drying*

Drying air temperature	Drying interval	Bed condition	Mill yield	
			head	total
°*F.*	*Min.*		*Pct.*	*Pct.*
Air dried check				
120	2	Static	64.7	75.5
120	2	Fluid	63.2	75.5
120	5	Static	62.4	75.4
120	5	Fluid	62.6	75.7
120	10	Static	62.4	75.5
120	10	Fluid	62.2	75.6
140	2	Static	62.8	75.9
140	2	Fluid	63.4	75.8
140	5	Static	62.0	75.3
140	5	Fluid	62.0	75.2
140	10	Static	61.6	75.7
140	10	Fluid	58.8	75.3
160	2	Static	62.2	75.4
160	2	Fluid	61.4	75.7
160	5	Static	58.8	75.4
160	5	Fluid	58.7	75.4
160	10	Static	55.2	75.4
160	10	Fluid	53.4	75.2
180	2	Static	57.8	75.3
180	2	Fluid	60.8	75.5
180	5	Static	43.8	74.9
180	5	Fluid	53.2	75.3
180	10	Static	32.0	75.2
180	10	Fluid	28.0	74.9
200	2	Static	55.2	75.3
200	2	Fluid	52.2	75.1
200	5	Static	33.4	74.6
200	5	Fluid	20.2	75.4
200	10	Static	25.0	74.3
200	10	Fluid	14.0	75.4

drying times for rice preheated with infrared and for conventional drying. Grain temperatures were on the order of 135° F. for the preheated rice, with drying air temperatures as indicated on the figure.

For static bed conditions, good milling yields and short drying time can be expected at 2-inch bed depths for air temperatures of 140° to 160° F.

Quality considerations.—Milling yields were determined for all the drying experiments for head and total yields. Table 4 summarizes head and total yields for the same drying series described earlier.

Table 4 indicates good milling yields under conditions consistent with the shortest total drying time. High milling yields were obtained for drying intervals of 2 minutes, under both static and fluid bed conditions.

Figure 5 is a summary of milling quality for three conditions of rice drying. From figure 5, it is evident that good quality was obtained using infrared preheat, particularly for 2-minute drying intervals. Two-minute drying intervals are

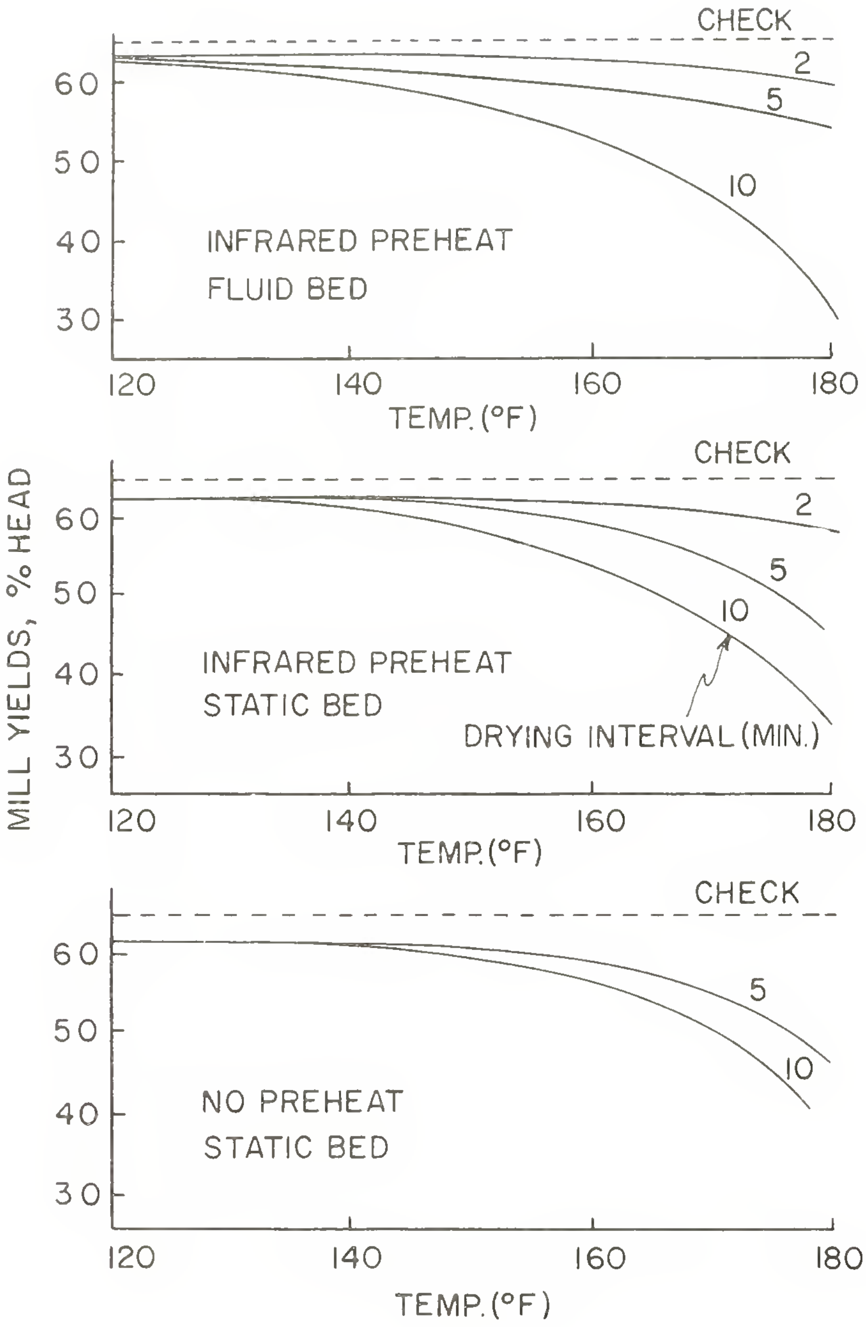


FIGURE 5 – EFFECT OF TEMPERATURE AND DRYING INTERVAL UPON MILL YIELD OF BLUEBONNET 50 ROUGH RICE

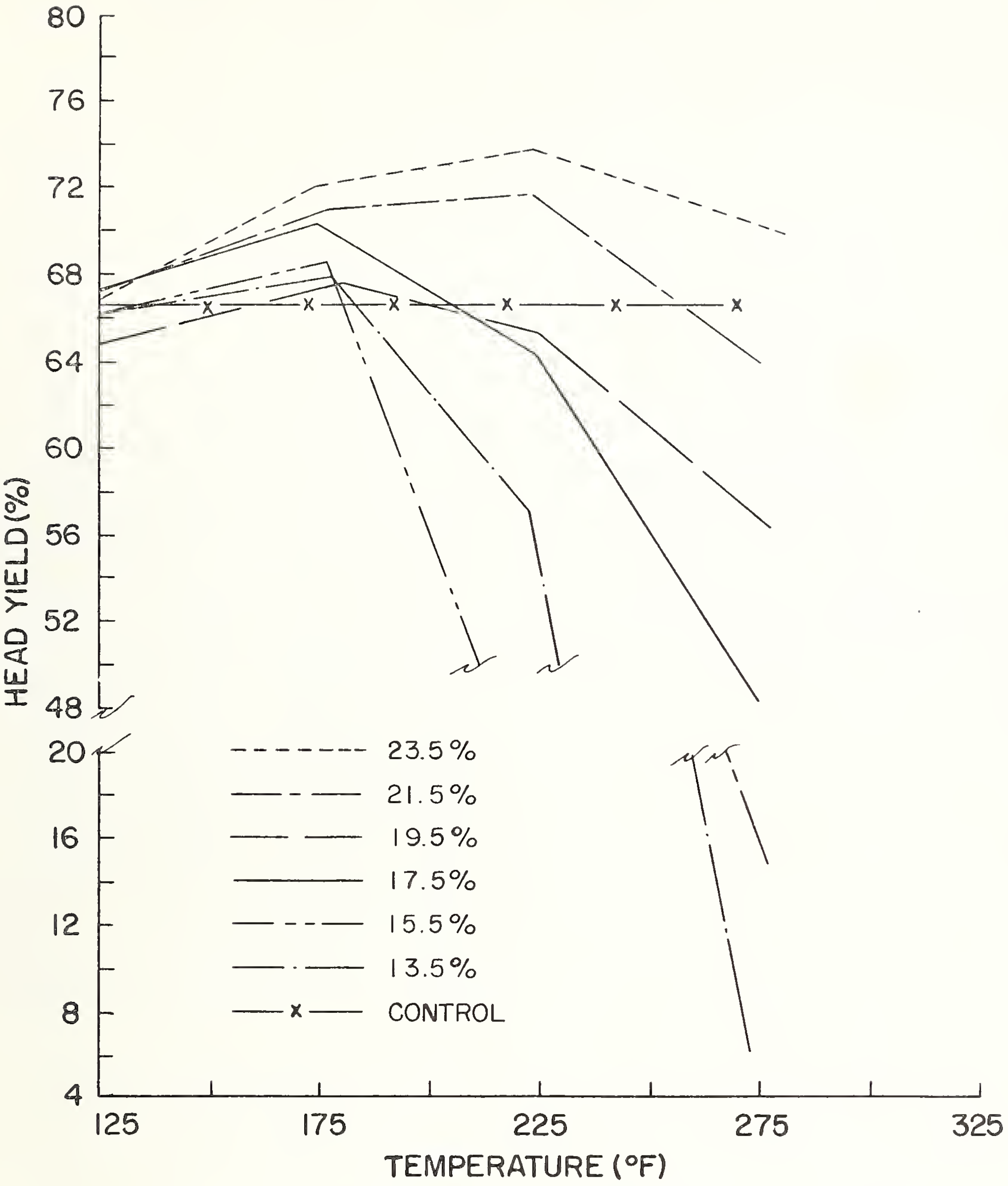


FIGURE 6 — HEAD YIELDS AS A FUNCTION OF MOISTURE CONTENT AND HIGH GRAIN TEMPERATURES FROM EXPOSURE TO INFRARED PREHEAT. SATURN.

Table 5.–*Rice germination as affected by drying air temperature following preheating with infrared radiation.*

Air temperature	Drying interval	Germination				
		REP I	REP II	REP III	REP IV	Mean
°F.[1]	*Min.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
120 S	2	77	86	78	85	81.50
120 S	2	92	95	93	90	92.25
120 F	2	90	90	92	88	90.00
120 F	2	94	90	94	92	92.50
120 S	5	91	94	97	93	93.75
120 S	5	95	93	96	94	94.45
120 F	5	87	90	95	91	91.00
120 F	5	91	87	92	92	90.50
120 S	10	84	92	86	91	88.25
120 S	10	93	87	86	92	89.50
120 F	10	99	96	92	93	95.00
120 F	10	92	92	93	94	92.75
140 S	2	84	89	88	90	87.75
140 S	2	98	92	89	94	93.25
140 F	2	82	81	81	78	80.50
140 F	2	89	85	90	93	89.25
140 S	5	93	86	79	86	86.25
140 S	5	89	91	88	92	90.00
140 F	5	83	83	87	82	83.75
140 F	5	81	79	74	84	79.50
140 S	10	85	77	76	82	80.00
140 S	10	86	87	90	88	87.75
140 F	10	70	69	70	65	68.50
140 F	10	82	89	80	85	82.00
160 S	2	40	42	38	33	38.25
160 S	2	59	61	67	63	62.50
160 F	2	17	34	40	33	31.00
160 F	2	39	31	38	41	37.25
160 S	5	39	40	39	40	39.50
160 S	5	28	33	42	37	35.00
160 F	5	1	2	2	5	2.50
160 F	5	1	3	2	1	1.75
160 S	10	31	36	39	34	35.00
160 S	10	35	33	31	37	34.00
160 F	10	0	0	1	0	0.25
160 F	10	0	0	0	0	0.00
Ambient	–	93	86	91	88	89.50
Do	–	91	81	82	84	84.50

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[1] S–following temperature denotes static drying bed.
F–following temperature denotes fluid drying bed.

now shown where preheating was not used, due to the long time, and consequent impracticality of using this drying interval. One important factor shown in figure 5 is that air temperatures of 140° to 160° F. can be used with preheating with little reduction in milling quality.

Discussion to this point has dealt with preheating the rice to approximately 130° with infrared. During some of the research, there were indications that head yields would be higher where grain temperatures were higher than 125° to 130° F. A series of experiments were designed to determine milling yields as a function of grain temperature, in order to establish more exactly the relationship.

Figure 6 is a summary of the results of milling yields as a function of grain temperature from heating with infrared. From figure 6, it is apparent that high head yields are attained up to 225° F. grain temperature for moisture contents over 21 percent. Highest head yields attained for rice under 21 percent moisture was at 175° F. grain temperature. One particularly significant factor indicated by figure 6 is that for all conditions of moisture content, there is a grain temperature that results in higher head yields than the air-dried control. For the highest moisture content and grain temperature of 225° F., as much as 5 percent head yield increase occurred. For all conditions of moisture content, 175° F. grain temperature resulted in good, if not maximum head yields.

Germination.—A series of drying experiments were conducted to determine the effect of preheating on germination. Maximum grain temperature for this series was 125° F., with drying intervals of 2, 5, and 10 minutes.

Table 5 summarizes the results of the experiment on germination. The data from table 5 are shown on Figure 7. From these data, it is apparent that drying intervals of 2 to 10 minutes could be used to safely dry seed rice. No limit has been established, however, for maximum grain temperature.

SUMMARY

From the information obtained through research, it has been established that rice can be dried using infrared as a preheat source in shorter periods of time than in conventional driers. Table 6 summarizes conditions considered to be consistent with short total drying time, good quality, and with equipment readily available.

Table 6.—*Summary of drying conditions for infrared preheat rice drying*

Condition	Quantity
Dry interval	two minutes
Bed depth (grain depth for drying)	two inches
Grain temperature	175° F.
Drying air temperature	140° to 160° F.
Radiator temperature	1,600° to 1,700° F.
Wavelengths (peak)	2.5 to 4 microns
Exposure time to IR	1 second
Heater height	5 feet
Heater width	1 in. for each 500 lb. of grain per hour

Design of a prototype system utilizing infrared as a preheat source for rice drying.—The basic design criteria for the preheat drying system is outlined in table 6. It was desirable to develop a drying system with a flow of 8 tons per hour (16,000 pounds). Under these conditions, it was determined that 2 tons per hour had to be finish dried.

Figure 8 shows the basic flow diagram for the system devised to accommodate the above-described conditions. Table 7 outlines the design assumptions and conditions.

Figure 9 shows a sectional cut view taken through the drier used to remove the moisture from the rice immediately after preheating. The drier is a modified LSU design. The modifications are largely dimensional in character, rather than conceptual. Grain depths for the drier were to be approximately 2 inches, consequently, the air inlet and outlet parts were sized and spaced to attain that depth.

Figure 10 shows the complete design schematically. Very basically, the system is one in which the rice grain is in free fall for 1 second between facing parallel infrared plates operating at about 1,700° F., where the grain temperature is raised to 175°. From the preheaters, the grain falls into a moisture removal section (drier), where

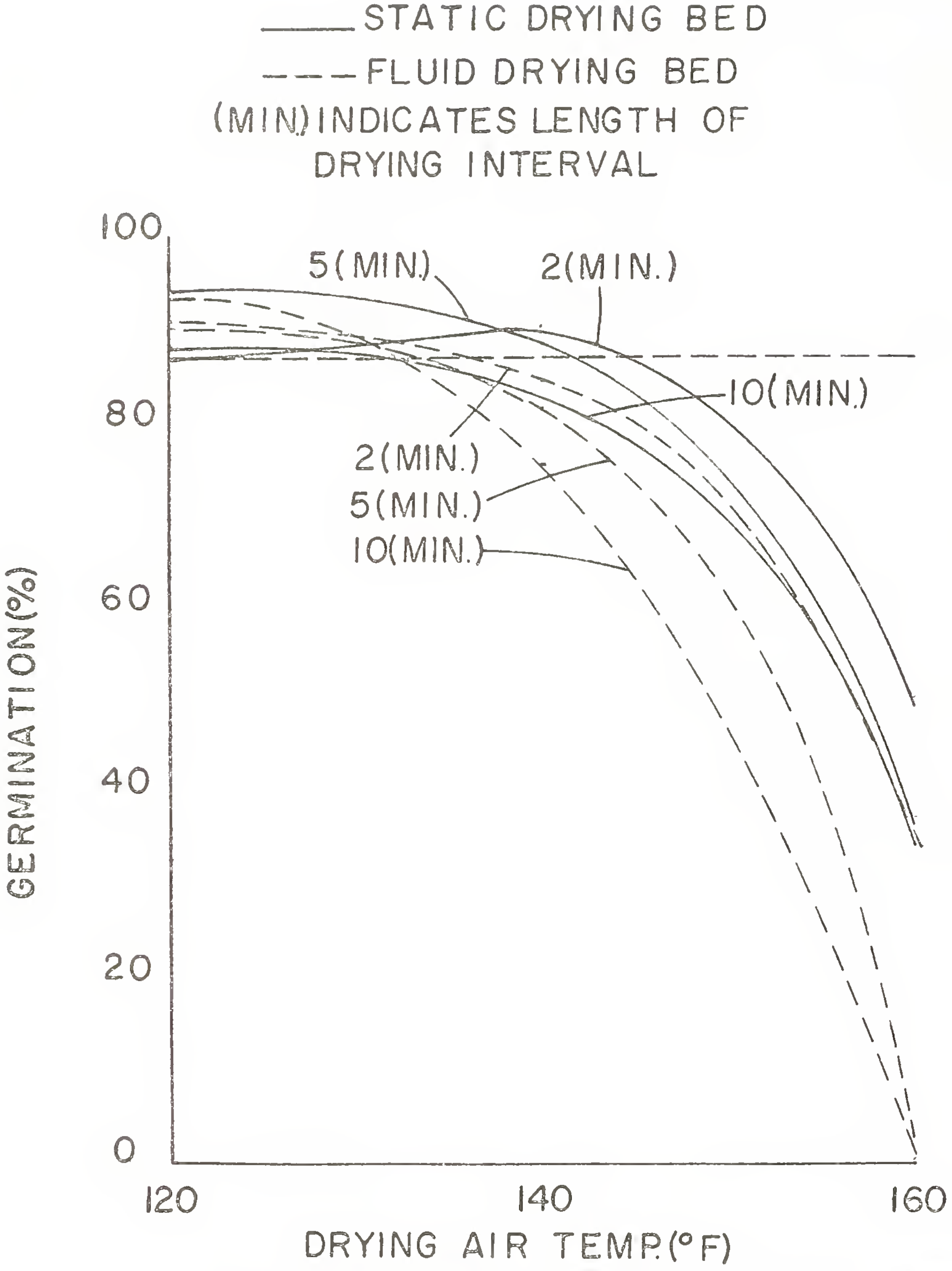

FIGURE 7-RELATIONSHIP OF GERMINATION TO DRYING AIR TEMPERATURE OF RICE PREHEATED WITH INFRARED

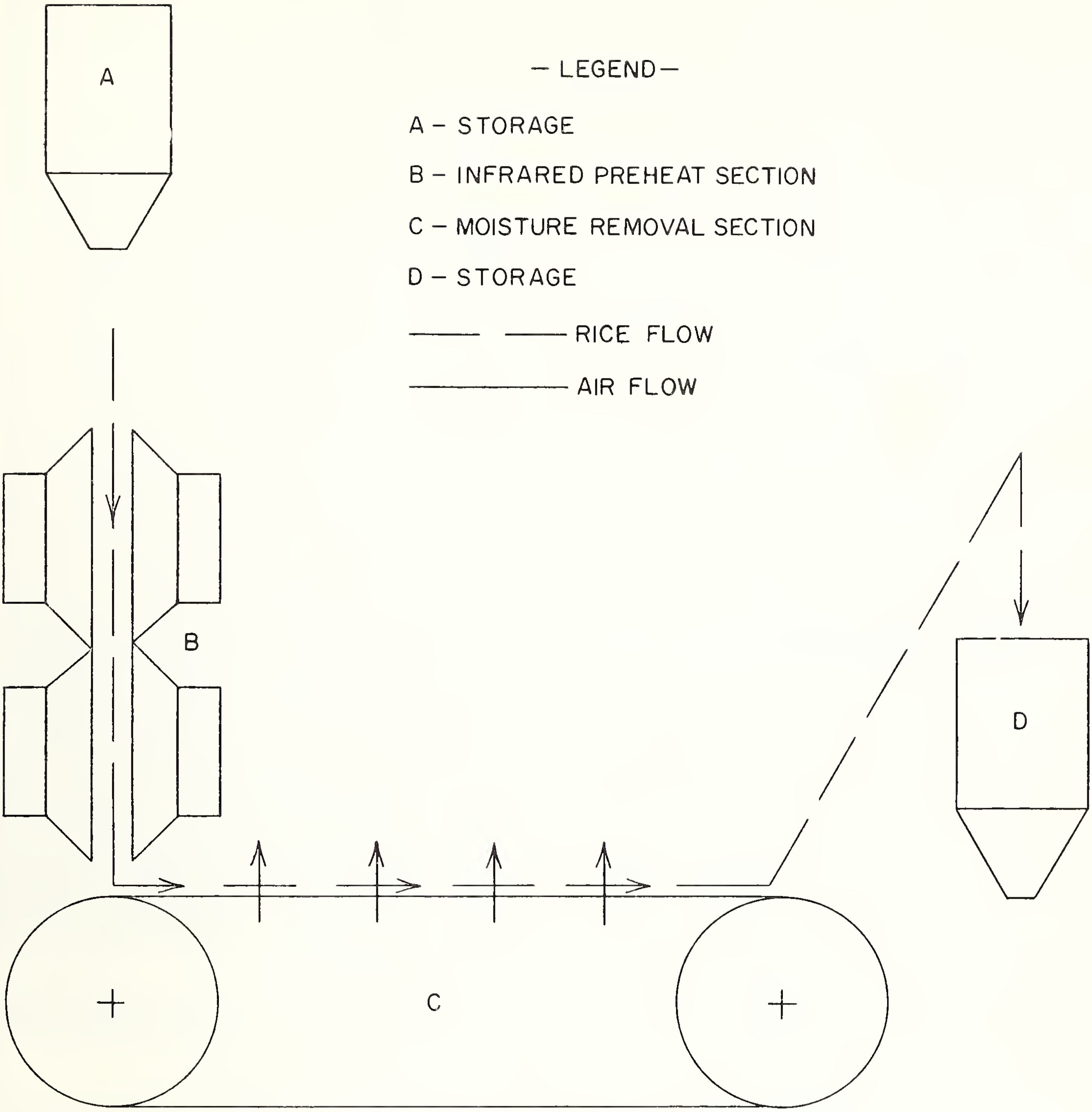

FIGURE 8 – SCHEMATIC FLOW DIAGRAM FOR INFRARED ROUGH RICE DRIER.

Table 7.–*Design assumption and conditions for preheating 16,000 pounds of rough rice for drying.*

Assumption–and conditions for preheating	Quantity
Initial moisture content	20 pct. (W.B.)
Final moisture content	12 pct. (W.B.)
Flow rate	16,000 lb./hr.
Final drying rate	4,000 lb./hr.
Number of passes	4
Time in drier	2 to 3 minutes
Size of drier (holding capacity)	533 to 810 lb.
Size of heaters (width x 5 ft.)	36 in. (500 lb./hr. x 36 in.)=18,000 lb./hr.
Rated temperature of heaters	1,700° F.
Output of heaters	1,010,880 B.t.u./hr.
Heat required to raise temperature of 16,000 lb./hr. – 100° F.	608,000 B.t.u./hr.
Fuel source	Natural gas
Heater input requirements	1,560,000 B.t.u./hr.
Conveying capacity	20,000 lb./hr.
Air flow through grain	100 ft./min.

approximately 2 to 3 percent moisture is removed per drying interval of 2 to 3 minutes. The air flow through the grain in the drier is 100 feet per minute, and its temperature is 140° to 160°.

From the drier, the grain is returned to storage for 12 to 24 hours, then the process of preheating and drying is repeated until the grain is dry.

Because of the inability to get equipment delivery and installation, the drier installed in 1969 was used to dry only two small lots of rice. Table 8 shows some typical results obtained in drying these two lots. These data are not considered conclusive, but rather representative of results obtained up to this time.

Table 8 represents a random sampling of results from the drier, and shows no particular patterns. However, they do show overall drying potentials. The drier was designed to remove on an average of 2 percent per pass through, or a total of 8 percent in four passes. The average moisture content removed per pass over the range considered has been 2.45 percent. This removal was during check-out and adjustment and should increase once complete operational techniques have been established. The data shown in table 8 are all for 3-minute drying intervals (time in drier).

Conservatively, it can be estimated at this

Table 8.–*Some typical drying results from infrared preheat and drying in a prototype system*

Drying air temperature	Preheated grain temperature	Drier discharge temperature	Moisture content		
			In	Out	Removed
° F.	*° F.*	*° F.*	*Pct.*	*Pct.*	*Pct.*
120	140	111	15.15	13.51	1.64
120	155	112	15.47	13.27	2.20
120	155	109	19.19	16.04	3.15
120	165	109	19.60	16.04	3.56
135	135	115	14.37	12.63	1.74
140	130	110	13.58	11.15	2.43
				Mean	2.45

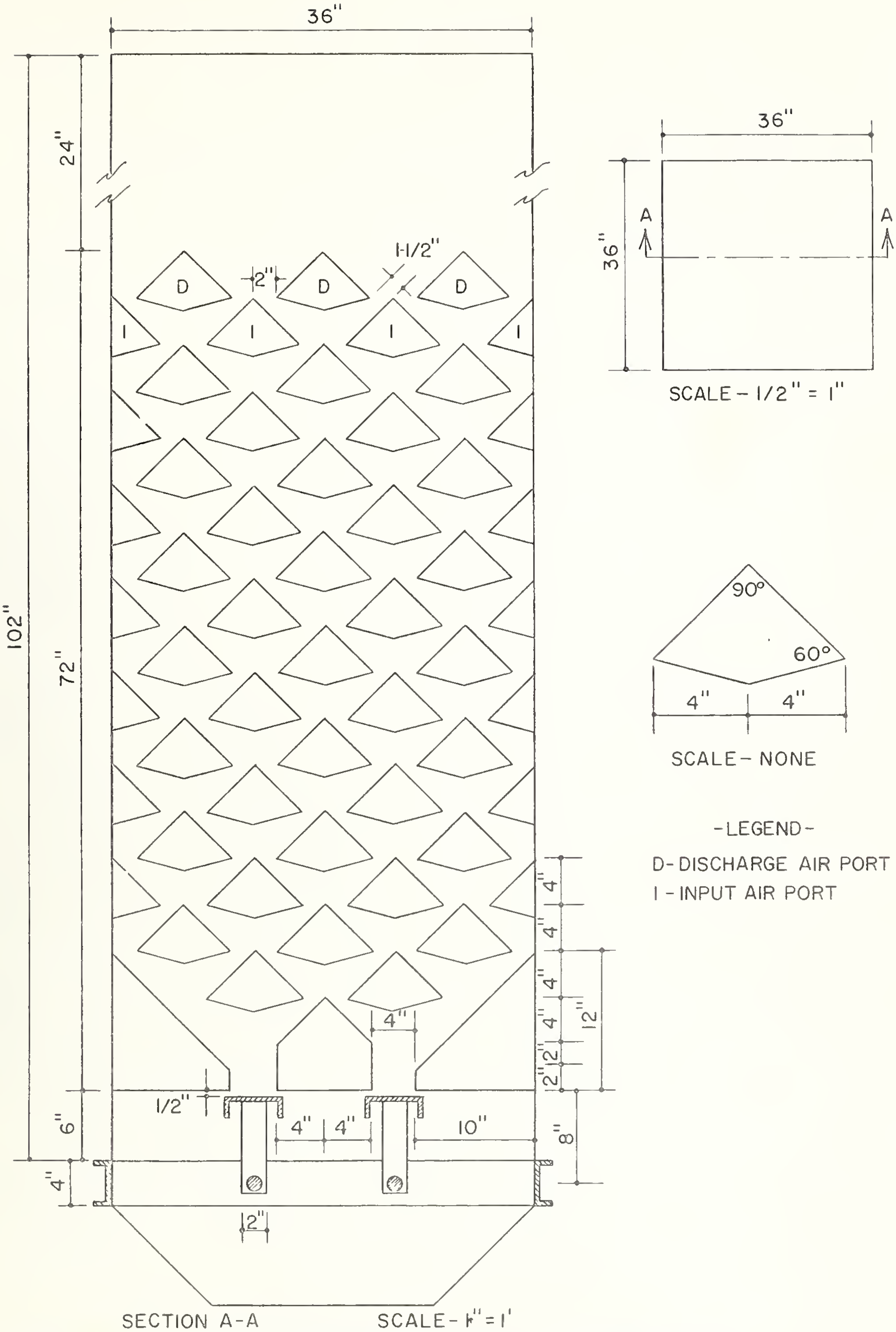

FIGURE 9 - SECTIONAL VIEW OF THE DRIER USED IN THE LOUISIANA STATE UNIVERSITY INFRARED PREHEAT RICE DRYING SYSTEM.

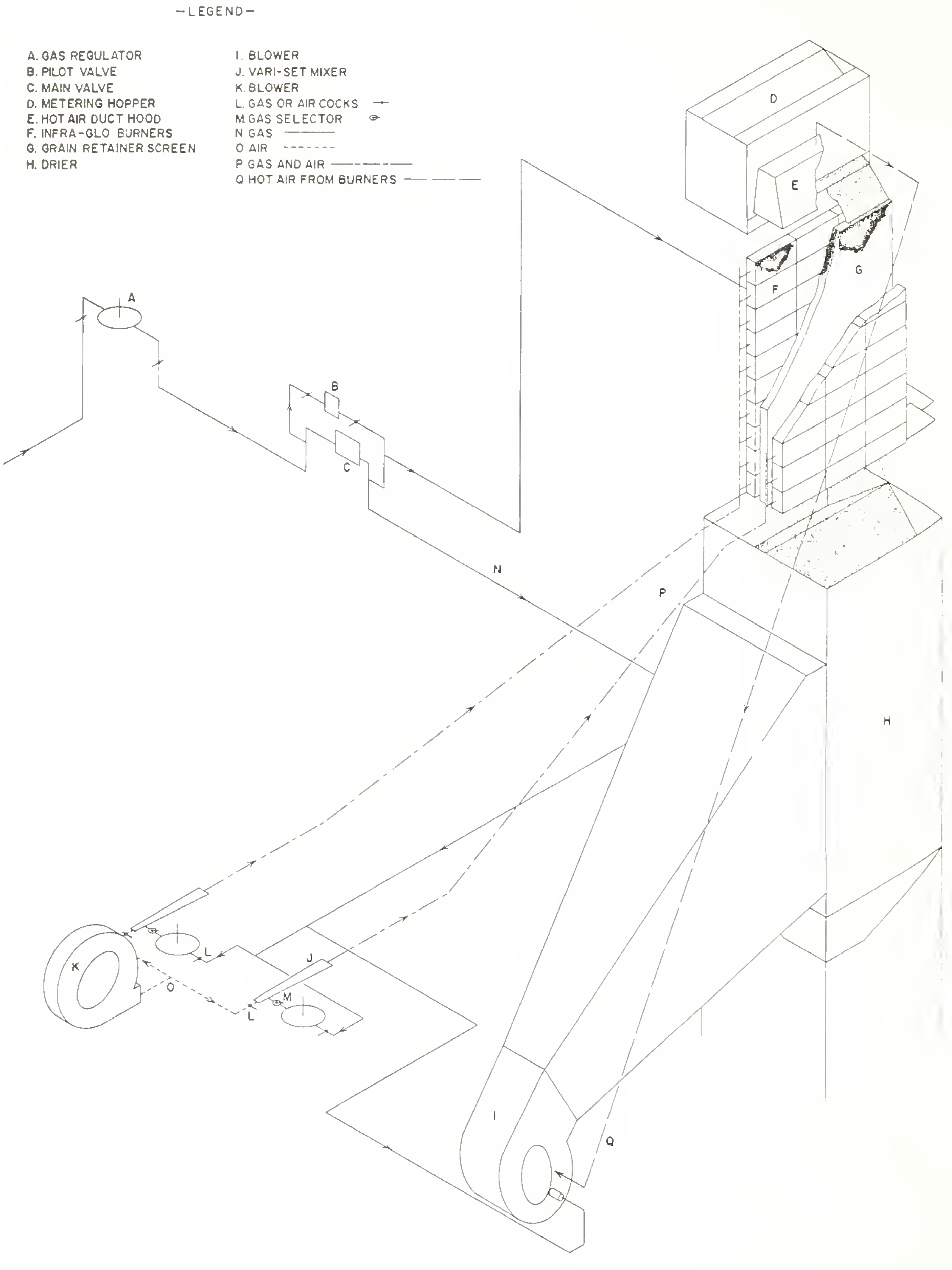

FIGURE 10 - SCHEMATIC DIAGRAM FOR THE LOUISIANA STATE UNIVERSITY INFRARED PREHEAT RICE DRIER

time that the drier should dry a normal lot of rice from 20 to 12 percent in four 3-minute passes, for a total of 12 minutes.

No attempt has been made to analyze milling yields from the prototype system, because of the limited amount dried. Once operational techniques are determined, a complete quality analysis will be made.

RESEARCH PLANNING–NATIONAL SCALE

by

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A three day symposium on the subject, "Resource Allocation in Agricultural Research," was held at the University of Minnesota in February of last year. I want to quote a number of excerpts from the preliminary report of that symposium by way of getting into this discussion today. This paragraph appears early in the report, and I quote:

> "While research benefits to society have been assumed implicitly, many observers argue that the nature of these benefits has not been made explicit enough. Not all benefits are measurable in numerical values. Yet there is considerable evidence that agricultural science has accelerated change in farmer and consumer behavior and in the economics of the farm enterprise. Hybrid corn research strikingly illustrates how an investment in science pays. The current rate of return on all past hybrid corn research is estimated to exceed 700 percent. While the value of hybrid corn research may appear obvious in retrospect, allocating resources to some research projects and not to others is now a pressing social and intellectual problem. The allocation problem is further complicated because much publicly supported research is organized around graduate education programs so that the investment in the research process simultaneously generates new knowledge and trains additional research personnel."

Remember the subject of that symposium was "Resource Allocation in Agricultural Research." The first paragraph under the heading, "The Problem of Resource Allocation" follows:

> "Organized research may be defined as the economic sector that discovers and develops knowledge which may be transformed into new skills and materials. There is a distinction between the objectives of research undertaken by firms for profit and by public and private agencies not for the profit of those agencies. Much of the knowledge created through basic and applied research, particularly in the biological and social sciences, becomes directly available to the public. This knowledge generated by research differs from most goods produced for private consumption in that utilization of the new knowledge by one client does not reduce the amount available to others."

Moving on to specific reference to publicly supported research is this quote:

> "State and Federal agricultural research may be viewed as a form of non-profit research which presents a substantial problem in allocation of available resources with little direct guidance from the pricing system. The economic contribution of public supported agricultural research to the nation's productive capacity is widely recognized. However, there is some disagreement regarding how smoothly the benefits flow from research to society and the distribution of the research benefits among economic sectors and income groups. At best, only applied research is

likely to have a direct connection between knowledge output and social benefits."

Attention was given to kind of research that deals primarily with social welfare and the allocation of resources thereto:

"Most symposium participants accepted the view that social benefits may accrue from research, but their views parted when it came to stating who should determine the social welfare function and whether social welfare should be considered in each allocation decision. One speaker stated that the ultimate responsibility for determining this function rests with legislative bodies; others stress the wide range of decisions which must be made by scientists and by research administrators. It is often pointed out that research agencies should bear a major responsibility for "externalities" or social side effects of research. New research planning may be regarded as a form of adaptive activity, and resource allocation—whether, how much, and which projects to support—is a special form of adaptation involving the joint response of legislators, research administrators, and scientists to changes in the matrix of economic, social, physical and educational circumstances. Within this matrix legislative bodies select the broad social goals and priorities and research administrators and individual scientists allocate the research resources to best meet those goals and priorities."

Then there was an attempt to assess the degree to which state agricultural experiment station programs are planned, or whether they live and grow with no considered design:

"Resource allocation in state agricultural experiment stations is characterized by heavy emphasis on production research and a fairly stable distribution among research areas over a time . . . This stability seems to stem from a variety of democratic and social pressures for various departments to receive and maintain a proportionate share of station budgets. Although a planning concept may emerge at the experiment stations, practice in past years is explained better by a traditional philosophy of service to farmers, ingrained at a time when a large percentage of the population was employed in farming and primary benefits of agricultural research were widespread. Although this philosophy may still prevail at many stations, there appeared to be general agreement at the symposium that consumers, rather than farmers, are the primary benefactors of agricultural research today."

A discussion under the heading, "National Trends in Allocation" dealt mainly with USDA programming and use of Federal origin resources:

"1. The initial approach to public sector budgeting in the U.S. had a "control" orientation which emphasized central control of spending. Prime concerns were to locate responsibility, maintain close scrutiny of departmental work, and prevent administrative improprieties.

2. With the New Deal, however, there came a gradual shift to a "management" orientation. With many previous administrative abuses now under control, budgeting could be freed from many of its watchdog activities and directed more toward efficient performance of work. The performance budget, introduced by the Hoover Commission, was a major contribution of the management orientation.

3. A third stage in budget evolution is the "planning" orientation illustrated by the PPBS system, with roots in Keynesian economics and systems analysis technology. The main goal of program budgeting with its planning orientation is to rationalize policy making in two principal ways. One, it provides data on costs and benefits of alternative ways of attaining proposed public objectives and secondly, it measures output to facilitate attainment of chosen objectives. Whereas prior approaches and classical accounting might assume a fixed objective, the systems analysis approach of PPBS would treat the objective itself as a variable. Full scale analysis might lead to a new statement of objectives."

Let us lay aside this quite unfairly brief synopsis of the Minnesota symposium with this final excerpt:

"Symposium reports and discussion indicated that not all issues are amenable to the algebra of the PPBS methodology. There are, on the contrary, a number of issues involving economic theory, administrative policy, and national philosophy which require concentrated attention. One issue concerns location of experiment stations and the scale on which they operate. Another is whether social costs resulting from research should be internalized as part of the cost of research or whether there should be a social welfare policy for handling research spillover and undesirable social side effects. A third issue might be labeled social welfare vs. incrementalism in allocation decisions. A fourth question is whether we are ready to try new techniques to evaluate research."

My purpose in taking this much of your time and attention on the Minnesota symposium is threefold: (1) To emphasize the complexity that is inherent in the planning, programming, budgeting and administration of agricultural research; (2) to point out that administrators, research staff, legislators, and laymen who determine the pattern and magnitude of research programs all are genuinely concerned that the best possible job be done with the resources that are available; and (3) to say that research planning on a regional and national scale is indispensable to the success of this second-mentioned point.

Now for a summary look at what actually is being done toward the planning of research on a national and regional scale. You know about the gigantic job of inventory and projection that was done in 1965 and 1966 which was published as the report of a study sponsored jointly by the Association of State Universities and Land-Grant Colleges and the U.S. Department of Agriculture, entitled, "A National Program of Research for Agriculture." That study and report began with a qualitative and quantitative inventory of the agricultural research that was in progress as of the year closed June 30, 1965 and projected increases and expansion through the year ending June 30, 1977. This work was categorized in 97 research problem areas of which 35 were subdivided into 287 subareas. The whole program was thereby broken down into some 350 categories. These numbers relate entirely to public agency research; that is, work of the U.S. Department of Agriculture and the State Agriculture Experiment Stations. The total production was envisioned as a 10-year plan, aimed at the target levels sighted by adding the projected increases, Research Problem Area (RPA) by (RPA), to the 1965 inventory levels.

The next step in this national scale effort was the development of commodity or activity studies and reports by 32 national task forces. Several of your own scientists and administrators served on those task forces. This brought the work of the overall Long Range Study a step closer to the research scientist and to the individual State experiment station and USDA research agency. You understand these commodity task forces thought and dealt in the same Research Problem Area and Scientist Man Year terminology as was used in the overall Long Range Study.

The third logical step in the planning process is underway now, and will continue in progress for 2 to 4 years. This step is the formation and functioning of numerous regional task forces to review and break down the national task force reports to regional applicability. These regional task forces draw upon their knowledge of the subject in their area; consider any other pertinent resource material that may be available to them; and, above all, exercise their good judgement as to the real problems, feasible research approaches and attainable objectives. An undetermined but large number of these task forces are at work now in the four regions of the State Agricultural Experiment Stations (SAES). Two have been newly organized and are underway in the South. The USDA has joined with State Experiment Stations in the membership of these two task forces. One deals with Environmental Quality, the other with Food and Human Nutrition. The objective of all of these regional task forces is to bring the subject of their effort into tangible grasp of the several SAES and USDA agencies, and to facilitate maximum research productivity from the resource input of cooperating SAES and USDA. Clearly the research must be done within and by the participating SAES and USDA agencies. Any nationally envisioned program is feasible, therefore, only as it becomes tangible to the scientists and their organizations who will perform the research.

Meanwhile, the State Experiment directors have been busy analyzing and adjusting the 10-year target levels of the several Research Problem Areas. They have held to the overall increases in Scientist Man Year effort *per State*, but have adjusted extensively among RPA's with further study of commodity and activity groupings of RPA's. These adjustments have been made within the State by the director, in consultation with his staff and with directors of neighboring States and to some degree with USDA administrators. The adjusted target levels of SMY input thus become valuable guides to the regional subject area task forces as they envision a research package for their respective subjects.

You may well be wondering what real value has accrued to this effort and costly input into planning at the regional and national level. No real increase in Federal fund support, in terms of buying power, has been realized in the 4 years since 1965, you are certainly aware. Nor have you experienced nor observed any great strides toward increased cozy combination of research effort among State and Federal researchers.

Look deeper into the pool of complex factors which control research productivity, however. One, nominal dollar increases in Federal funds have been received. A responsible staff member of the U.S. Bureau of the Budget advised us that we certainly would have suffered actual decreases in dollar appropriations but for the Long Range Study. Two, the USDA has been under a depressing manpower ceiling for this entire period. They are forbidden to refill many of their existing positions as openings occur, and have but minimum chance of creating new positions. The ceiling is being maintained generally governmentwide.

Three, the kind of program analyses and planning which have been described here are highly valuable in the inescapable process of readjustment and retrenchment when the fiscal going gets tough, and that is now. Four, this kind of research planning is indicated and necessary at all times and under all conditions if resource input is to yield maximum research returns. We are well along our way in the planning process at the national level, and that would have taken about this many years to accomplish under the most favorable conditions. I refer here primarily to each State experiment station doing an indepth analysis of its own program, to neighboring States tooling up to plan together and to cooperative planning of the SAES and the USDA. All three of these points of emphasis are essential to meaningful national planning.

On recommendation of a joint task force of top administrators sponsored a year ago by the National Association of State Universities and Land-Grant Colleges and the U.S. Department of Agriculture, a standing joint committee of these two organizations was established. This committee known as the Agricultural Research Policy Advisory Committee (ARPAC) determines broad policy guides for these two public agency research groups, and recommends same to the Secretary of Agriculture and to administrators in the Universities. President William L. Giles, Mississippi State University, and Director Ned D. Bayley of USDA's Science and Education are cochairmen of the Committee. State Station Directors, Deans of Agriculture and Administrators of research agencies in the USDA and of Forestry in the States make up the membership. They meet about four times a year.

There is a work horse subcommittee of ARPAC called the Agricultural Research Program and Facilities (ARPF) Committee. ARPF —it is called the arf committee. The dogs who comprise this committee are the four regional directors for the State Experiment Stations, a representative of the State forestry research group and a like number, five, research administrators of the USDA. This 10-man joint Federal-State subcommittee meets as needed, four to six times a year; does preliminary thinking and calculations for ARPAC; helps shape up the agenda for the ARPAC meetings and is guided generally by policy statements and assignments of ARPAC to it.

Meanwhile, there is the major committee of the Experiment Station Directors known as ESCOP, the Experiment Station Committee on Organization and Policy, which develops and voices policy guides of the Directors. This is the principal committee of the Experiment Station Section of the Division of Agriculture of the National Association of State Universities and Land-Grant Colleges. This is a key committee in matters of Federal legislation and appropriation of fund support to the State Experiment

Stations.

Recapping briefly what I have said on Re search Planning—National Scale:

1. Agricultural research is complex by nature. The public agencies, State and Federal, who perform agricultural research are so numerous, widespread geographically and autonomous administratively that a highly involved organization and procedure are required to inventory present work and project future plans.

2. The organization in the form of committees and task forces to accomplish this job of planning has been developed in the past 5 years and is functioning.

3. State Experiment Stations, with or without USDA cooperation depending upon the component of research under consideration, are in excellent position to envision partnership effort across Statelines and to strengthen teamwork research within the home State.

4. This elaborate pattern and procedure for planning agricultural research, national scale, is required to (a) combine and integrate resource input by multiple SAES and USDA; (b) avoid unnecessary duplication; and (c) present a convincing story of problems to be solved, promise of solution through research, and the need for input resources to do the job.

Two specific areas of research are of special concern to the South. One of these areas relates to food, the other to textiles.

The South potentially is in a favorable position competitively with respect to the rest of North America in the production, processing and distribution of finished food supplies. Nature provides free a favorable climate with a long growing season and mild winter, minimizing the cost of housing of animals and other protection agains the elements. In fact a plentiful labor supply exists. The job that must be done for a successful and satisfying agricultural economy in the South is to develop a technology which will capitalize upon the favorable climate for production of food crops, meat, milk, eggs, and marine resources; and provide productive employment for the managerial ability and available labor for production and processing of all of those food commodities into consumer-use products. A comparable approach is applicable to the production and processing of fiber into usuable textiles.

Greatly intensified general education plus expanded training in trade and industrial skills will be required to bring together the existing labor force and the production and processing job which is to be done.

An enlarged program of research, financed by public funds, will be necessary for the development of the technology here envisioned. Likewise, research is a prerequisite for the educational and training program that must be done.

This session of your conference does not afford the time and opportunity to delve into more specifics of the research program which is indicated by the circumstances of Southern economy. Suffice it to say (1) that expanded production and utilization of food will be via the commercial route, not by the home garden and chickenhouse; and, (2), productive employment of millions of presently underemployed workers in the South will go a long way toward restoring economic stability and quieting the social unrest.

COTTONSEED FLOUR—GLANDLESS-GLANDED

by

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(Presented by H. L. E. Vix)

It is my privilege to report on an area of research that appears to be gaining rapidly in importance. Let me summarize briefly the historical background and then show you with concrete evidence why the work of the Southern Utilization Research and Development Division

(SURDD) scientists is now filled with great excitement over future prospects.

For a long time cotton dominated American agriculture and the seed produced was an unwanted byproduct. In the latter half of the Nineteenth Century, new cottonseed mills were reported in operation after many false starts and the industry grew slowly. In the beginning of the Twentieth Century, technology had advanced to where a good edible oil could be obtained and from it many food products made. The meal was used for cattle feed. Cottonseed became a valuable product of the production of cotton representing approximately 10 percent of the total value of the crop at the farm level. However, the seed remains a byproduct of lint production and depends upon factors governing the level of lint production.

For several generations hydraulic pressing was the prime method used for removing oil. Before and immediately after World War II the industry experienced a transition period in which cottonseed operations were changed to achieve economy in processing and improvements in the quality of the meal as well as the oil. This caused a real revolution in the processing of cottonseed with the result that hydraulic pressing has all but disappeared from the scene and cottonseed is currently processed by screw pressing, solvent extraction, and prepress solvent extraction. It was about this time that SURDD came into being undertaking considerable research of value to the cottonseed industry. The industry on its part, did considerable research of its own and helped development advance at an even greater pace. Nevertheless, the meal today is still principally a feed material in the marketplace.

Now, there seems to be on the horizon a new dimension in processing cottonseed realized through research at an opportune time. Scientists at SURDD figured prominently in lauching this research to unveil the virtues of cottonseed meal. They have converted it into protein products—flours, concentrates, and isolates—that show potential for food with many end-use applications where functionality of the protein is desirable. The present pressure on population explosion and the resultant search for increased protein sources of nutritional value to feed the hungry of the world has caused a resurgence of interest in seed proteins; in their isolation, chemistry, preparation, properties, and the like. Seed proteins have always been of practical interest as a major source of food protein for man and animal, and currently the nutritional and functional aspects are dominating a heavy percentage of the research.

We have been fortunate at SURDD to lead in the development of two types of flours from cottonseed: one from glanded, and the other, from glandless cottonseed. The biggest difference between the two varieties is the presence of pigment glands in the former and their absence in the latter, as illustrated in figure 1. Figure 1 shows half sections of glanded and glandless seed. Those sections marked by dark dots—pigment glands—are the glanded sections and the clean white ones are those of the glandless seed.

Figure 2 shows a flake made from glanded cottonseed and here, again, the glands are clearly visible. A similar flake from glandless seed would look very much like this one except that it would not contain any dark spots or glands.

In the genetic development of glandless cottonseed, Scott C. McMichael (6), U.S. Cotton Field Station, Shafter, Calif., crossed Hopi Moencopi with Acala cotton. Glandless seeds were selected from among the thousands of plants for several generations before a true breeding, glandless seeded strain containing an extremely low quantity of gossypol was developed. In the intervening years, breeders have been growing glandless strains. Lately, large numbers of acres have been planted to glandless varieties and tons of experimental seed have been processed in commercial mills. Recently, a paper has been published by Cross and coworkers (2) showing that conventional direct extraction is entirely feasible for processing glandless cottonseed. A high grade light-colored oil, and meal and flour of light color can be obtained by controlled desolventization of the marc.

At SURDD, during the past 5 years, extensive research has been underway to prepare an essentially white flour, bland in flavor, from glandless cottonseed; one in which the protein is of a quality equal to that in the original seed. Many tons of glandless cottonseed have been processed in our pilot plant to produce sizeable quantities of meal and flour for additional

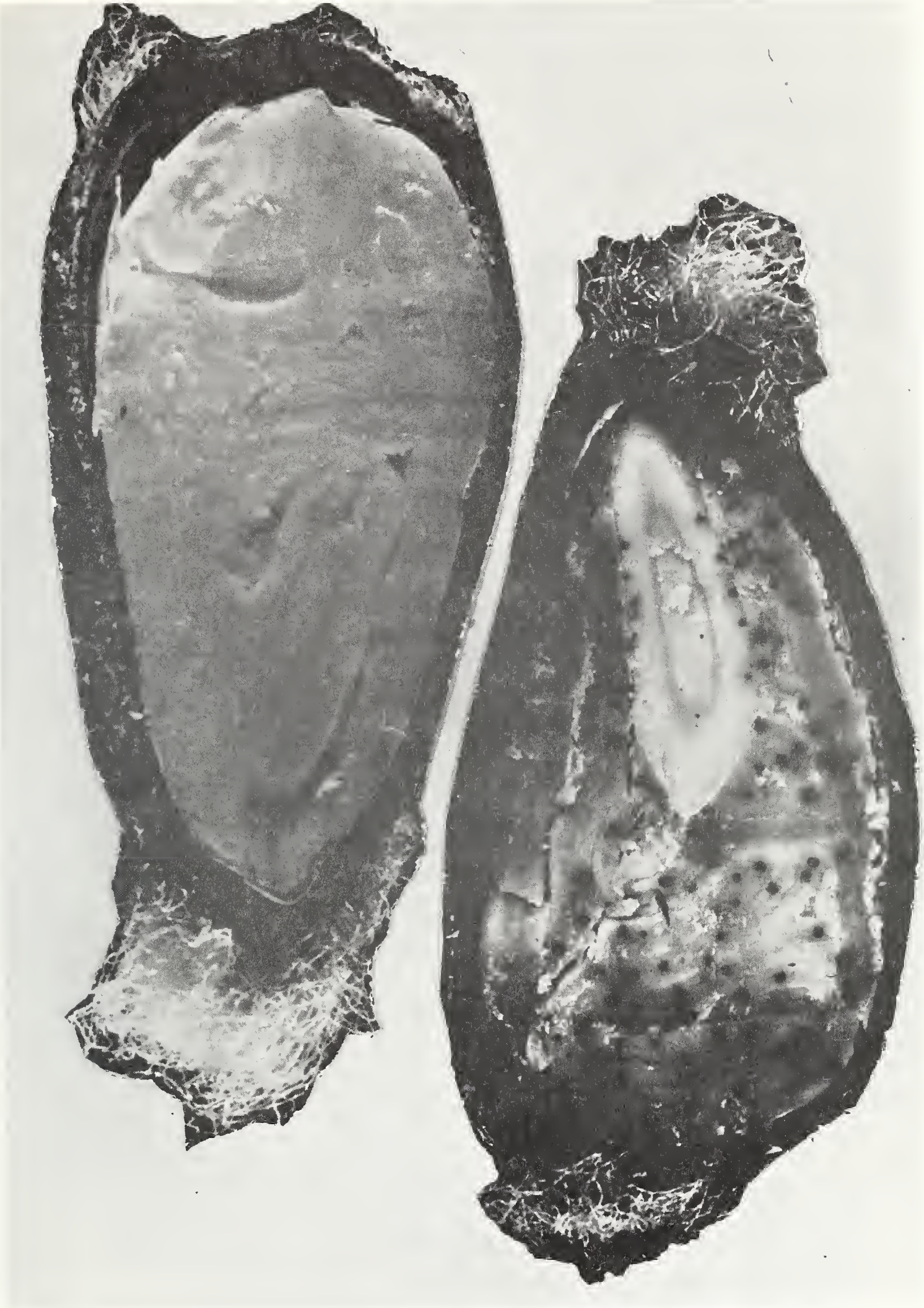

Figure 1.—LONGITUDINAL SECTIONS OF GLANDED COTTONSEED SHOWING INTEGRITY OF GLANDS AND SIMILAR SECTIONS OF GLANDLESS SEED SHOWING ABSENCE OF GLANDS.

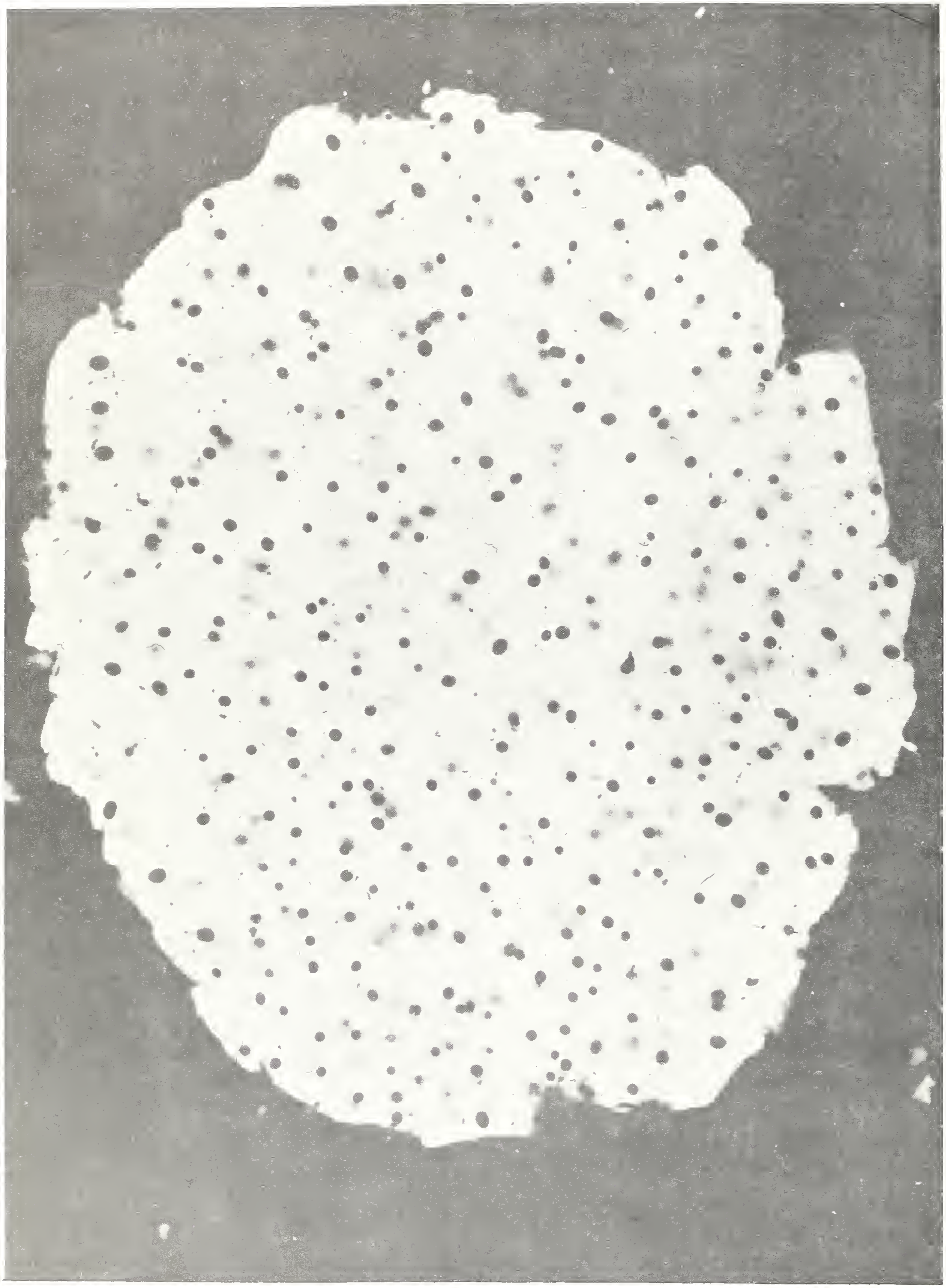

Figure 2.—GLANDED COTTONSEED FLAKE SHOWING PIGMENT GLANDS.

research, that is, air classification and protein preparation and evaluation by food processing industries. Three varieties of glandless cottonseed, namely, Acala, Gregg, and Watson were used in these studies. Usually the seed was delintered and equilibrated with additional moisture to yield a whole meats fraction with a moisture content of approximately 9 percent on hulling. Through such a procedure, it was possible to obtain a yield of whole and cracked meats of approximately 70 percent of the total weight of the meats. Only whole and cracked meats were flaked, directly extracted with commercial hexane, and the resultant solvent-damp meal desolventized at room temperature. It was learned that desolventization of this meal must be conducted at temperatures sufficiently low to avoid extensive darkening and denaturing of the protein. Research showed that maximum temperatures in the range of 150° and perhaps to 170° F. might be used in continuous commercial operations,

Processing of glandless cottonseed in commercial-scale solvent extraction plants has been conducted on an experimental basis. One run was made in a mill at Leland, Miss., another at Lubbock, Tex., and a more recent one at a mill in Oklahoma City. This run, as well as the earlier ones, were arranged by the National Cottonseed Products Association, with SURDD, Texas A&M, and industry representatives participating. Approximately 200 tons of glandless cottonseed were processed at this mill in October 1969. All the meats stream used together with the usual quantity of hulls. The meats were tempered with a slight addition of moisture, flaked, and directly extracted in a Crown-type extraction unit. The extracted meal was desolventized at a maximum temperature of 145° to 150° F. The extracted meal was first screened through a 12-mesh screen to remove most of the hulls. At another location, the through-fraction was put through an Entoleter, a 60-mesh screen and a Bauermeister grinding mill. From the through-fraction of the 12-mesh operation, a yield of 76 percent of fine flour was obtained. The flour from the Oklahoma run was only slightly darker than that obtained during SURDD's pilot plant operations.

Table 1 shows a typical analysis of the Acala variety, processed in the pilot plant at SURDD and the Watson variety from the Oklahoma run. Analyses of the other SURDD pilot plant flours are similar to that of the Acala flour.

Table 1.–*Approximate composition of flour products made from Acala*[1] *and Watson*[2] *varieties of glandless cottonseed*

Composition	Acala	Watson
	Pct.	Pct.
Moisture	9.9	9.5
Lipids	0.40	2.40
Gossypol, free	0.003	0.040
Gossypol, total	0.007	0.060
Nitrogen	9.48	8.75
Protein	59.3	54.7
Protein solubility	99.4	95.7
Crude fiber	2.7	3.3
Ash	7.2	6.7
EAF lysine	3.90 g/16g. N	—

[1] Made in pilot plant at the Southern Utilization Research and Development Division.

[2] Processed at the Oklahoma City mill.

None of the current commercial processes for yielding oil and meal products from glanded cottonseed can be modified to produce a white flour comparable with that of direct solvent extraction of glandless cottonseed. Numerous polar solvent systems have been investigated for this purpose at SURDD. While the products have shown marked improvements, especially in nutritive value, they fall short in meeting consumer acceptance requirements, particularly for use in formulations by food industries. One approach, now meeting success, is a process under development at SURDD for the mechanical removal of intact pigment glands. Figure 3 shows some of the intact glands freed from protein and protein aggregates free of glands. The process is an outgrowth of earlier work at SURDD published in 1949 (7) on a differential settling method using commercial hexane as the solvent. This approach took advantage of the different frictional resistances of the various components of cottonseed to a liquid medium. The Liquid Cyclone process developed by Gastrock, D'Aquin, Eaves, and Cross (4) uses whole meats from the hullers. The process has recently been refined by Eaves and Gardner (3) to yield a product which comes close to approximating the quality of flour made from glandless cottonseed. While the flour from a glandless cottonseed is practically white, the product from the Liquid Cyclone Process is a light cream color.

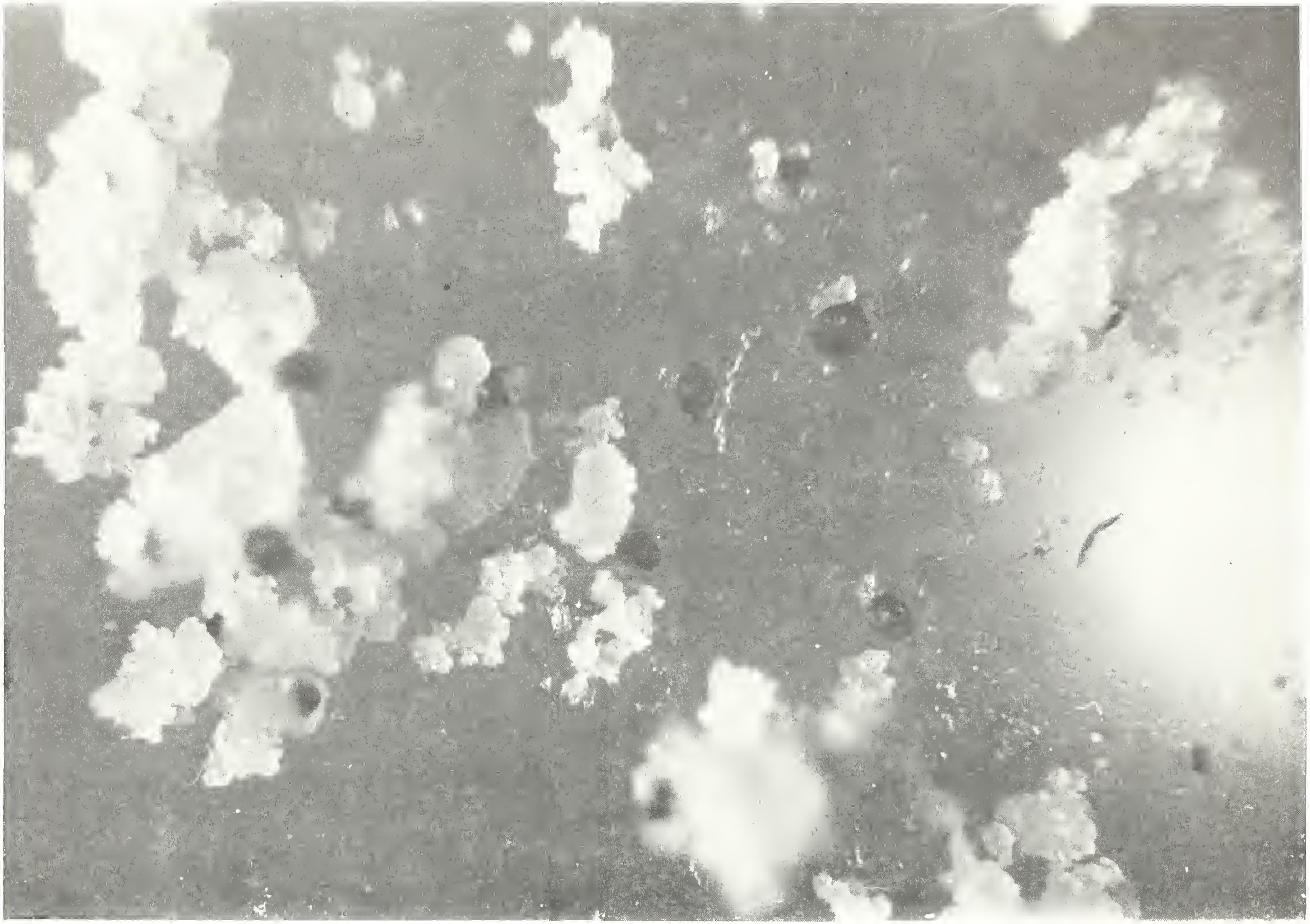

Figure 3.—GLANDS INTACT AFTER GRINDING AND FREE OF PROTEIN.

Figure 4 shows a flow diagram of the refined process. It consists in preparing a whole and cracked meats fraction, essentially hull free, from prime quality uncontaminated cottonseed; drying this fraction to a moisture content of 3 percent, flaking to 0.010 inch; preparing a fluidized slurry in hexane containing about 45 percent solids; and passing the fluidized slurry through a horizontal stone mill to detach the meat tissue from the pigment glands. The milled slurry is then diluted with additional hexane to a solids content from 20 to 25 percent and pumped under optimum pressure through a 3" diameter stainless steel liquid cyclone (fig. 5) to effect separation of two fractions—an overflow containing finely divided, high-protein flour essentially free of gossypol and an underflow containing pigment glands, coarse meat particles embedded with glands and some hull particles. After filtration, washing to remove oil, desolventization, drying, and sterilization, a high quality cottonseed flour is recovered. The underflow can be recycled to separate an additional quantity of the fine, high-protein flour essentially free of gossypol.

With the above unit operations, we have carried out five successful continuous runs in which about 7,700 pounds of cottonseed flakes were processed to produce approximately 1,700 pounds of high-quality edible flour all of which is to be used in evaluation studies. This flour has the analysis shown in table 2. The free gossypol content is of the same low order of magnitude as that of glandless seed (table 1), and the protein content, EAF lysine and nitrogen solubility are equally high. This sample is also bland in flavor and has an attractive light cream color. In fact, it closely approximates a concentrate in protein content. In these runs we obtained yields of the order of 33 to 35 percent flour based on the weight of solids input to the process. This, we feel, is low but we have gained quality at the expense of yield. We do believe, however, that the yield can be increased to enhance the economic desirability of the process.

Table 2.—*Chemical composition of LCP flour*[1] *prepared at the Southern Utilization Research and Development Division.*

Composition	Percent
Moisture	3.2
Lipids	1.2
Free gossypol	0.020
Total gossypol	0.065
Nitrogen	10.57
Protein	66.1
Protein in MFB	68.5
Nitrogen solubility	99.5
EAF lysine, g/16 g. N.	3.96
Fiber	2.3
Ash	8.9

[1] Flavor, bland; color, light cream.

There is considerable interest in the Liquid Cyclone Process (LCP) product in the United States and the product and process by which it is produced will probably have a significant impact on alleviating food shortages in those developing countries where cotton is grown. The process is currently being used successfully in India in a small-scale commercial operation.

The rosy future which we see for the cottonseed industry lies in coordinating the availability of glandless and glanded cottonseed with its processing under optimum sanitary conditions. The industry has the technology. If it is coupled with proper sanitary practices, there is no reason why food grade products cannot be made.

It is visualized that the above food products will be processed in a satellite plant operated in conjunction with the parent cottonseed oil mill. This satellite plant is one in which the highest sanitary conditions possible are maintained. Consideration must be given to neighboring plants, conditions of roadways, air intake into plant which should be protected by suitable filters, and to other sources of contamination to the products.

Currently at SURDD, we are getting total counts on all materials prepared in our pilot plant. As a result, we are beginning to see possibilities for controlling the bacterial count of the product during the desolventization operation. This is an important operation, not only because it can seriously affect the color of the product but also if conditions are right, it should act as a sterilizing operation for the product. Operations after desolventization, such as grinding of the meal to produce a flour, should be carried out under conditions comparable to those used in the food industry to prevent recontamination. It might be noted that,

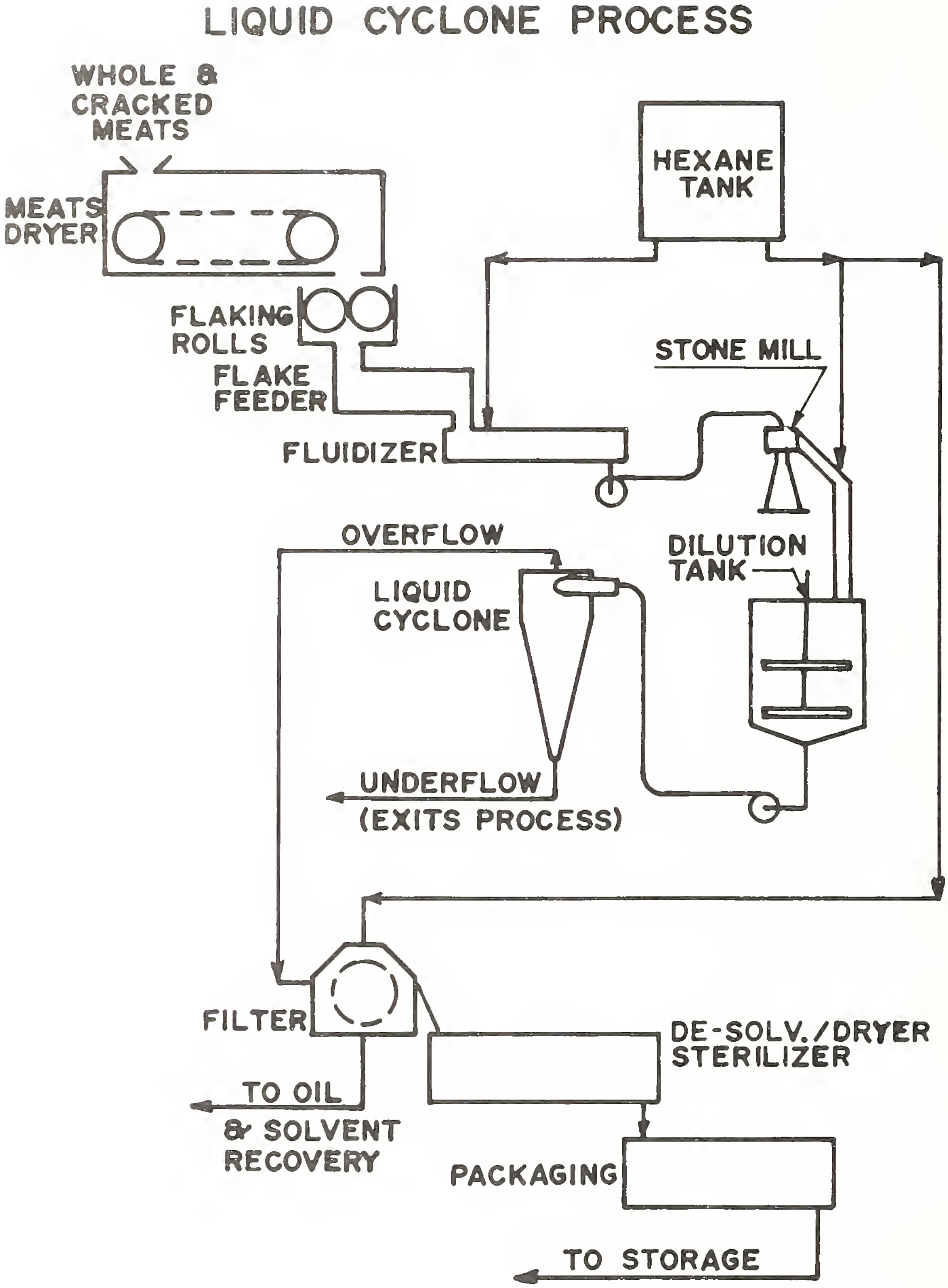

Figure 4.—THE LIQUID CYCLONE PROCESS.

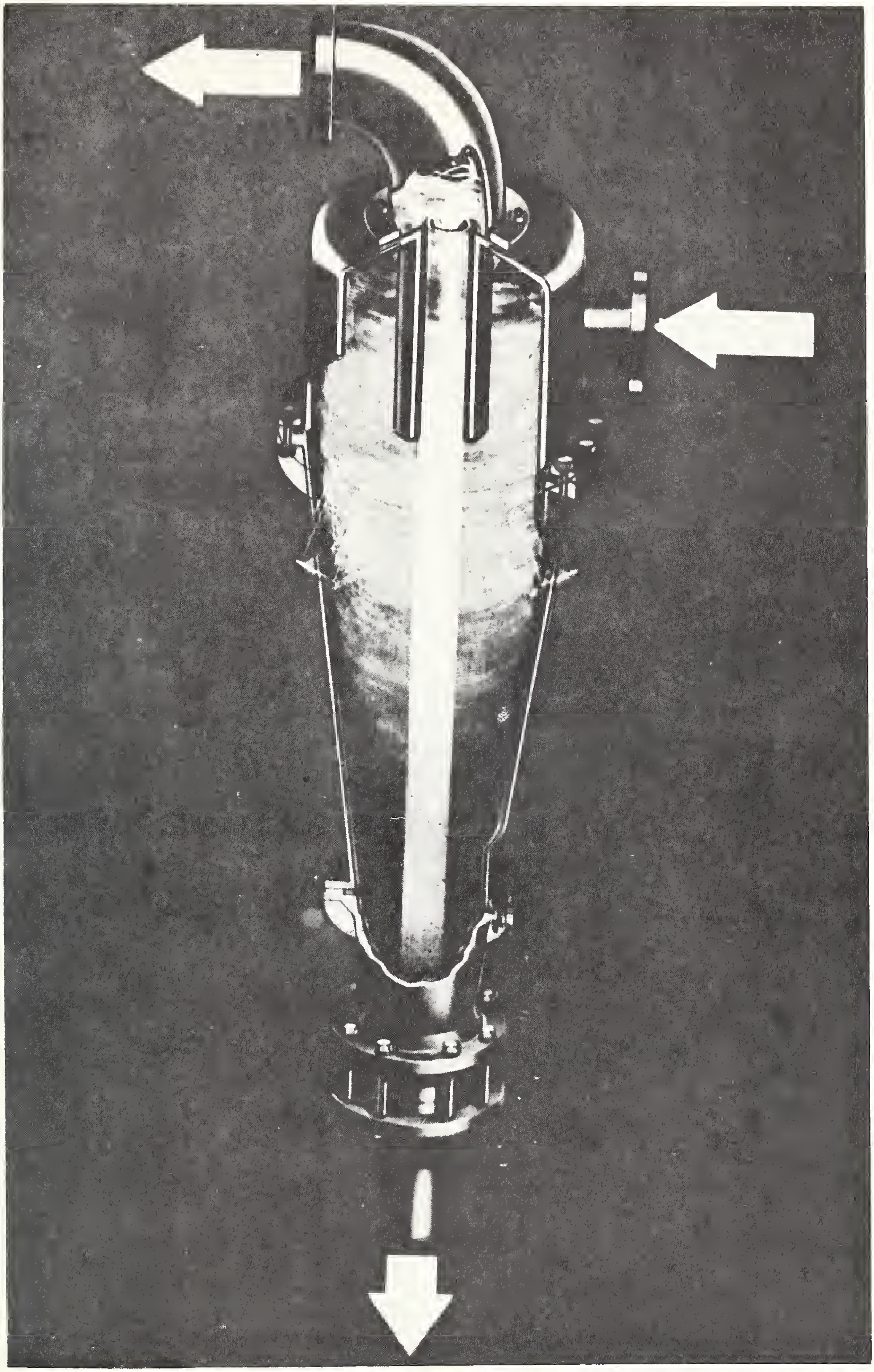

Figure 5.—LIQUID CYCLONE.

wherever possible, handling of the meal must be done cautiously with proper respect for aseptic-like practices which would include cleanliness of the building, personnel, machinery, and even air intake.

Now that we have such high grade flours from both glanded and glandless seed, we are anticipating their potential use not only in the preparation of good products by the food industry, but also as a basis for the preparation of other protein products such as concentrates and isolates. There are three major classes of plant protein products: flours, concentrates, and isolates—the chief distinguishing factor being protein content. We have already brought to your attention two new flours—one from glandless cottonseed and the other from glanded seed.

I will now summarize briefly those technological advances being made with these flours at SURDD. This work is spearheaded by Wilda Martinez (1, 5) and her associates of the Oilseed Crops Laboratory, in collaboration with the Engineering and Development Laboratory. This work formerly emphasized different methods of concentrating protein in the flours. Now it has expanded to include the functionality of the products and collaborative work on new end-uses for these products.

Protein in cottonseed flours can be concentrated in several ways including liquid or air classification and solvent or water extraction. The LCP flour about which I talked earlier is an example of a product of a liquid classification process.

Recently, investigations have shown that it will be commercially feasible to produce a concentrate (70-percent protein) from glandless cottonseed flour with commercial equipment by air classification. It is possible to obtain a product of 70-percent protein representing approximately 50-percent of the starting material. Lipids and fiber are low and ash is increased. Economic evaluation of the air classification process must be determined on the basis of end-uses of both products, the concentrate and the coarse residue. Hull fragments are not a critical problem during air classification because they are concentrated in the coarsest fraction.

Methods for preparing protein isolates have also been developed at SURDD. One is a two-step selected extraction of cottonseed flours with water followed by sodium hydroxide to yield two acid-precipitated protein isolates. A scheme for this method is shown in figure 6. The water extracted isolate No. 1 contained 13 percent-nitrogen and represented 21 percent of the total nitrogen. The alkaline-extracted isolate No. 2 contained 16-percent nitrogen and represented 58 percent of the total nitrogen. Isolates I and II differed in amino acid composition, molecular weight, and solubility characteristics. With a modified extraction schedule, the two-step procedure was eventually transferred to the pilot plant. The above work and also the successful separation of cottonseed protein from pigment glands in glanded seed by the Liquid Cyclone process are made possible by the fact that protein bodies, lipids, and other components of the cottonseed come naturally packaged in the tissue as shown in figure 7. This is a picture of a single cell. The elongated irregular shaped body in the center is the nucleus, the dark almost round bodies are the protein bodies, and the small white round particles surrounding the protein bodies are the spherosomes or lipid particles. The round white spots inside the protein bodies are sites of phytin storage. These are called globoids.

Figure 8 shows a pigment gland in the center. Just above the upper lefthand corner of this pigment gland there is a small dark particle. This is a single cell. This picture gives some idea of the comparison in size between a single cell and a pigment gland which makes possible the separation obtained in the Liquid Cyclone process.

The food industries are eagerly awaiting commercial production of the cottonseed flours, concentrates, and isolates which have been outlined for you. All that we need now is a dependable source of supply of food-grade flours. Some work is being conducted by the meatpacking, baking, and beverage industries to determine desirable functional properties. We can expect considerably more information in the future as this work develops. Here at SURDD tasty biscuits have been prepared using glandless and LCP flours as substitutes for white flour at levels of 5, 10, and 20 percent. Cooking-extrusion expansion operations[1] have produced

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[1] Spadaro, J. J., Mottern, H. H., and Gallo, A. S. Extrusion of Rice with Cottonseed and Peanut Flours. (Presented at the 1969 National Meeting of the American Association of Cereal Chemists, April 27 - May 1, 1969, Chicago, Ill.

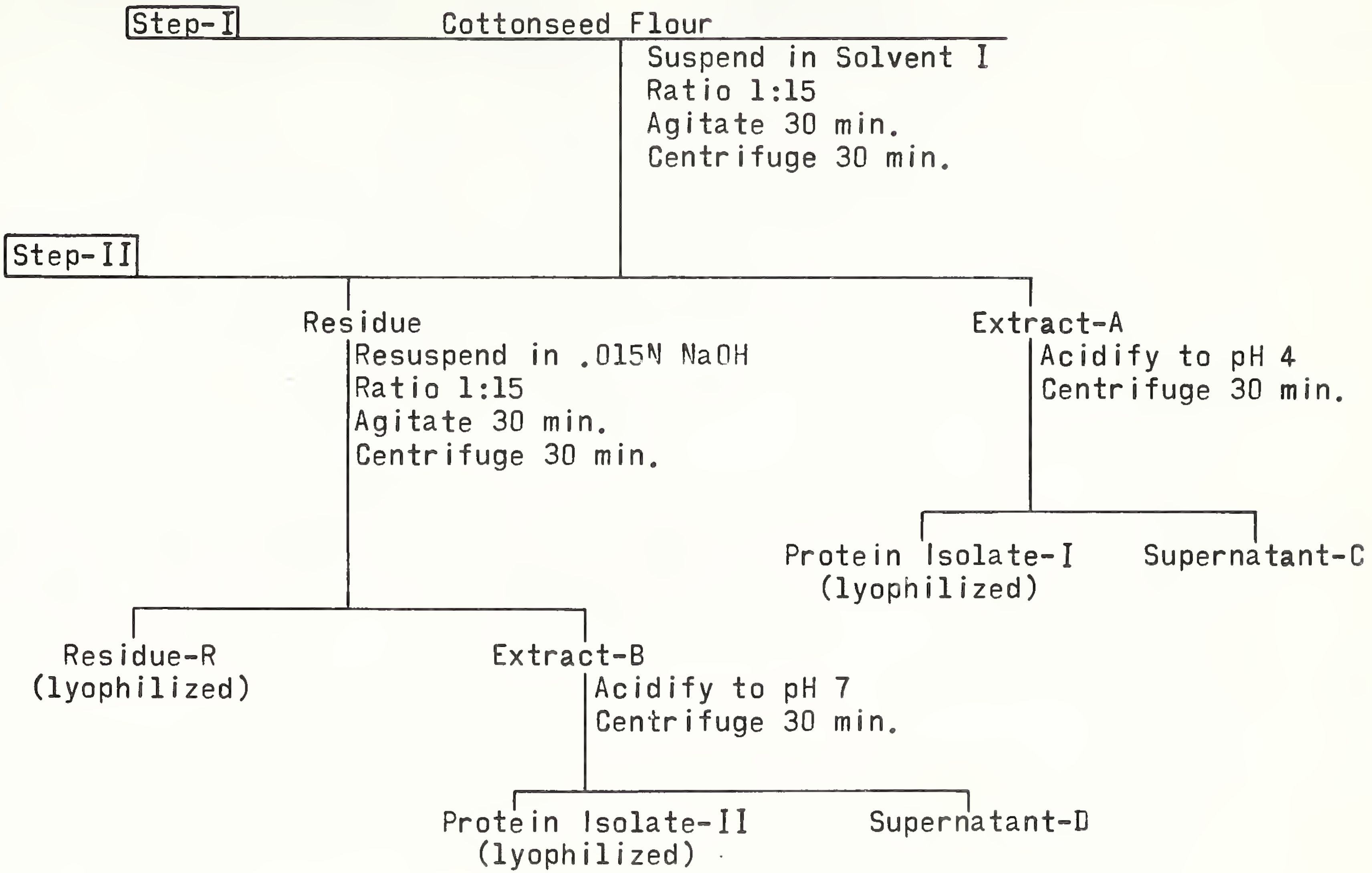

Figure 6.—FLOW DIAGRAM OF THE TWO-STEP, SELECTIVE EXTRACTION PROCEDURE FOR THE PREPARATION OF COTTONSEED ISOLATES.

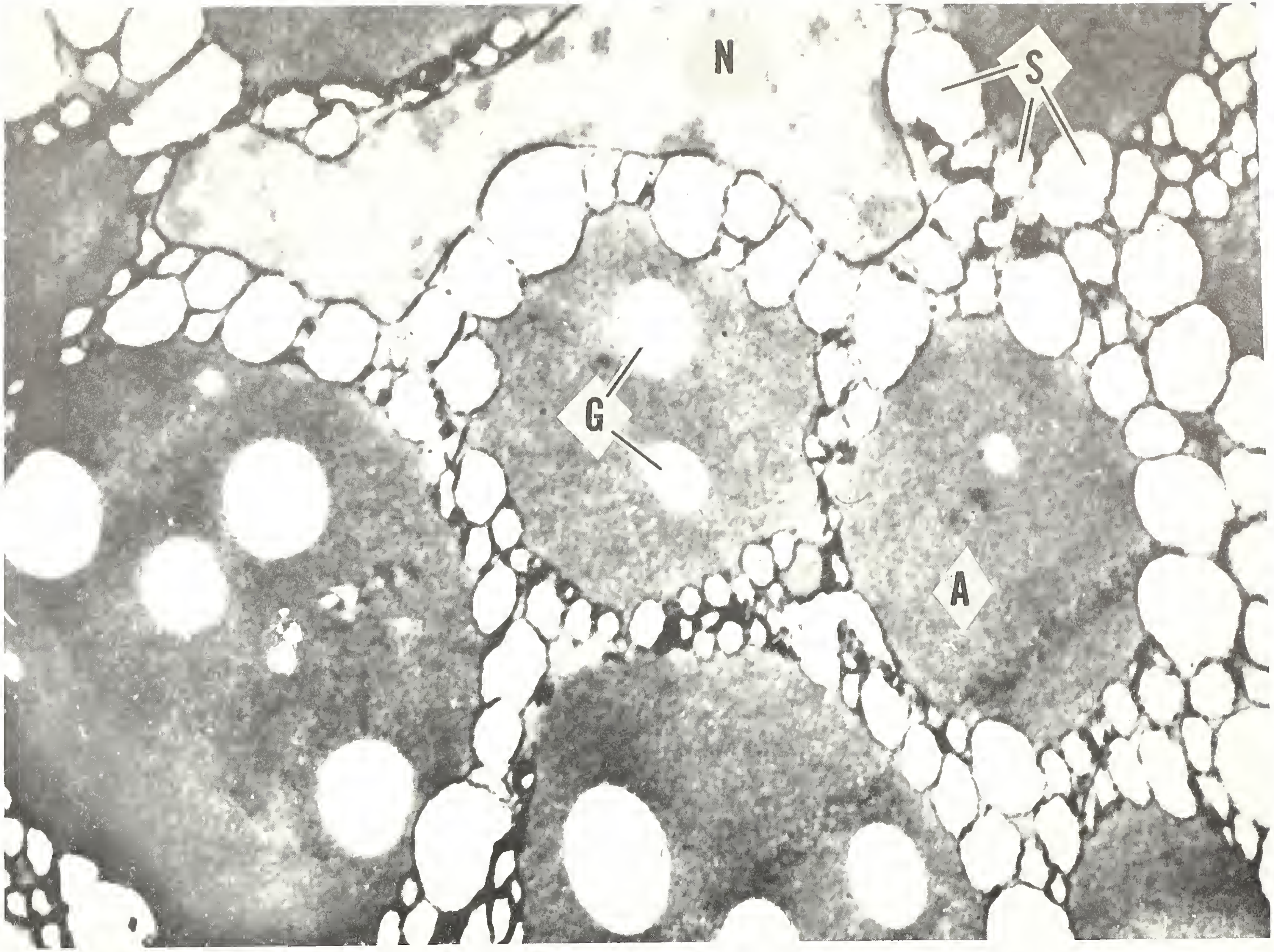

Figure 7.—SPONGY MESOPHYLL CELL FROM COTYLEDON OF DRY COTTON EMBRYO, ALEURONE GRAINS—PROTEIN BODIES (A), SPEROSOMES (S), GLOBOIDS (G), NUCLEUS (N). LITHIUM PERMANGANATE FIXATION. TAKEN AT 7000 X. COURTESY OF L. Y. YATSU.

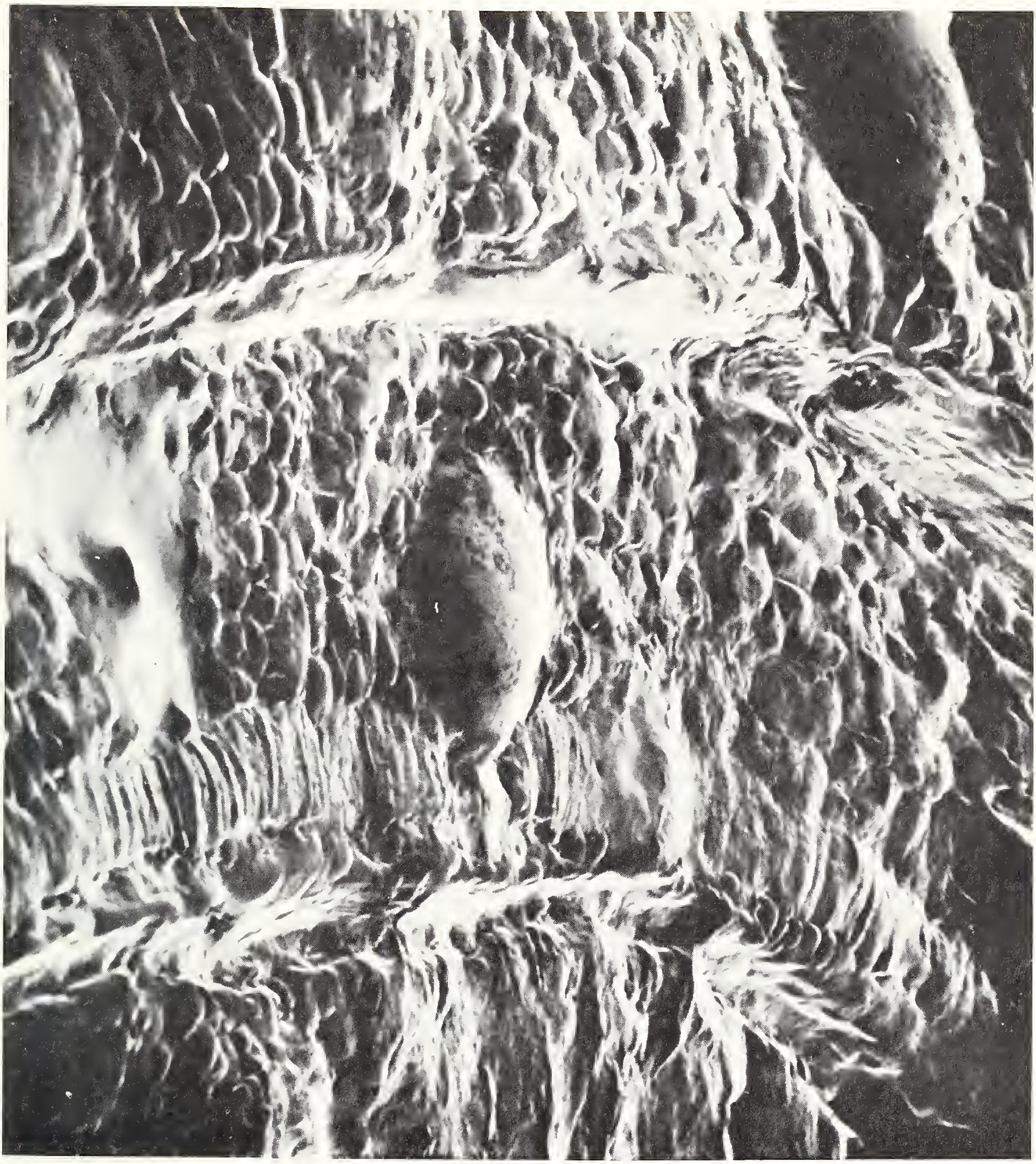

Figure 8.—SCANNING ELECTRON MICROGRAPH OF CROSS SECTION OF HYDRATED GLANDED COTTON EMBRYO. LARGE BULBOUS SHAPES ARE PIGMENT GLANDS. COURTESY OF W. R. GOYNES, JR.

material suitable for breakfast cereals and beverages. In this instance, a blend of cottonseed flour at a concentration level of 20 percent with rice grits was extruded successfully to make these products.

Present major markets for flours, concentrates, and isolates appear to be in meat, bakery products, and in textured food analogs. Small quantities of protein additives generally improve qualities important to the consumer, such as texture, homogeniety, fat dispersibility, and the like. Even white bread may be similarly improved by the addition of 3-percent protein.

In summary, I have tried to bring to your attention the developing interest of the food industry in plant proteins and particularly such protein flours, concentrates, and isolates as we have been able to prepare from both glandless and glanded cottonseed. Interest in these products is due to their low cost and attractive functional properties. I believe that the foregoing presentation should convince you that protein products from both glandless and glanded cottonseed *can* add a new dimension to the cottonseed industry and that this new dimension will undoubtedly lead to the production of high-grade food products where the market is unlimited.

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DISCUSSION

QUESTION: What is the estimated yield of flour per ton of raw cottonseed?

MR. VIX: That depends upon the process. On the oil-free basis, taking all the hulls out, up to about 500 to 600 pounds of 60-percent protein meal is potentially available from a ton of cottonseed. In the liquid process, a yield of approximately 200 pounds of 70-percent protein flour is obtained.

QUESTION: Do you have any estimate on cost?

MR. VIX: This is a challenging question. We are hopeful that the flour from the liquid cyclone process can be produced at a cost of probably 8 cents a pound. Producing a concentrate can bring the selling price up to 15 or 20 cents a pound and the isolate is expected to sell for about 40 cents a pound.

QUESTION: Do you get the same thing from okra seed? Are they closely related?

MR. VIX: I knew you would ask that question. I would say you would get a product similar to that from cottonseed. You will recall that 20 years ago, we did some extractions of okra seed for you, but I have forgotten the details. I do remember that we had a very light colored meal and the protein content was considerably lower than that of the cottonseed flour produced by the liquid cyclone process.

NEW FOOD PRODUCTS–SOYBEANS

by

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Our purpose is to review the use of soybeans as a food crop with emphasis on the more recent developments in food products. From a utilization viewpoint, soybeans and cottonseed have much in common. Both have been primarily a source of edible oil—particularly in the United States. The oil meal has been used mainly as a protein supplement for animal feeding. Food uses of soybean meal have progressed further than for cottonseed meal. However, the extent of such use still is rather small.

The differences between soybean and cottonseed are great enough, however, that these two raw materials should be looked upon as brothers rather than as identical twins. Differences are apparent both in the oil and in the meal and protein portions. These differences not only can give rise to a wider variety of end uses but also present the research man with a variety of problems to be solved.

Soybean oil has been enjoying an increasing food market for many years. The increases can be attributed, at least in part, to the progress in research directed toward an important difference between soybean oil and cottonseed oil; namely, in flavor stability. Soybean oil has less flavor stability because it contains around 8 percent of linolenic acid, which has three double bonds. The linolenic acid is particularly susceptible to oxidative and related changes giving rise to off-flavors. Two approaches are under consideration for solving the problem—one chemical and the other genetic. From the chemical standpoint, excellent progress is being made in studies on selective hydrogenation to eliminate linolenic acid by reducing one or two of the three double bonds. The genetic elimination of linolenic acid would give a more positive solution, but at present this approach appears rather discouraging. I understand that a recent informal report on measurements of linolenic acid in a large collection of genetic material failed to show any significant occurrence of low levels of linolenic acid. In fact, virtually all of the samples whose oil differed from that in our commercial soybeans were higher rather than lower in linolenic acid content. While the problem of flavor stability looms large in the eyes of the research scientist, we must conclude that soybean oil is a well-established food product for which minor deficiencies undoubtedly are going to be overcome through continuing research.

Turning to the protein portion of the soybean, we find that the situation is quite different. The use of soybean protein as a food still is quite limited in the United States. Much research has been done and more lies ahead. At the same time, the importance of food proteins places a sense of urgency on this area of research and development.

Plant proteins and specifically soybean protein have a wide range of opportunities in the food field. At one extreme is the feeding of the "hungry world" while at the other is the production of new sophisticated foods. In feeding the hungry world, of course, many of the problems are social and economic. However, there also are problems of acceptance of a new food or a new protein source, even though it fits the requirement of low cost. To avoid the difficulties of introducing a new product, we often emphasize the addition of the protein as a supplement to an existing food product, such as a loaf of bread. This approach provides an increase in the protein content and the quality of the protein in the diet without the problem of gaining acceptance of something which tastes or looks different from the customary foods. In addition, the cost of the foods can remain relatively low.

Sophisticated foods, on the other hand, represent a higher price level and may involve market development for unfamiliar forms of food. Among the sophisticated foods based on plant proteins are simulated meats, such as simulated turkey loaf, which fill special dietary needs or have advantages such as convenience and storage stability.

What is the status of soybean protein as a food material? The major outlets for soybean protein are conveniently summarized in terms of soybean meal, which is the starting point for most food products. By far the largest part (76 percent in 1968-69) goes to animal feeding domestically. Exports account for 21 percent of the soybean meal and this also goes almost entirely into animal feeds. The remainder of 3 percent includes all nonfeed uses, that is, both industrial and food uses. About half of the 3 percent goes into food use. While this seems like a small amount, it represents about a fourth of a million tons and the amount is increasing.

Representative food uses of soy protein are listed below:

Food uses of soy protein:

1. Whipping agent in confections and dessert mixes
2. Infant foods
3. Breakfast foods
4. Bakery products
5. Beverages
6. Meat products
7. Simulated meats
8. Flavoring agents
9. Dietary foods

Some of these uses are based on nutrition, for example, infant foods, dietary foods, and some of the beverages. The others generally are based on functional properties of the soybean protein. More will be said about these properties shortly.

The commercial forms of soybean protein are listed in table 1 together with the prices and approximate quantities produced in 1967. The flours and grits generally are defatted, although full-fat flour is produced to a limited extent. For food uses, a protein content of around 50 percent for the defatted product is customary and reflects nearly complete removal of hulls during processing. The protein concentrate (about 70 percent protein) and the isolate (90 percent and above) are produced from meal or grits. The increase in price with increasing protein content results from the cost of processing and the effect of yields obtained. At the same time, these prices do reflect the value that the user places on these products. The total amount of soy flour and grits produced is about 200 million pounds, of which roughly half was used in CSM (corn-soy-milk food supplement). Exact production figures are difficult to obtain, particularly for concentrates and isolates. However, the values shown are considered reasonably indicative of the present marketing of these products.

The lowest cost form of soybean protein—defatted flour or grits—actually consists of a range of products rather than a single one. The important variable in the processing (fig. 1) is the toasting step which consists of a moist heat treatment. Toasting is omitted if the soy flour is to be used, for example, as a bleaching agent in bread where activity of the oxidative enzymes is desired. In contrast, for some food uses toasting is necessary because it improves flavor and destroys antinutritional factors. Despite the ad-

Table 1.—*Cost and production estimates of soybean protein*

Protein forms	Protein content	Cost per pound	Estimated production[1]
	Percent	*Cents*	*Million lb.*
Flours and grits	40 to 50	6-1/2 to 7	105 to 110[2]
Concentrates	70	18	17 to 30
Isolates	90 to 95	35 to 39	22 to 35

[1] Estimate for 1967

[2] An additional 100 million lbs. was used to corn-soy-milk product (CSM)

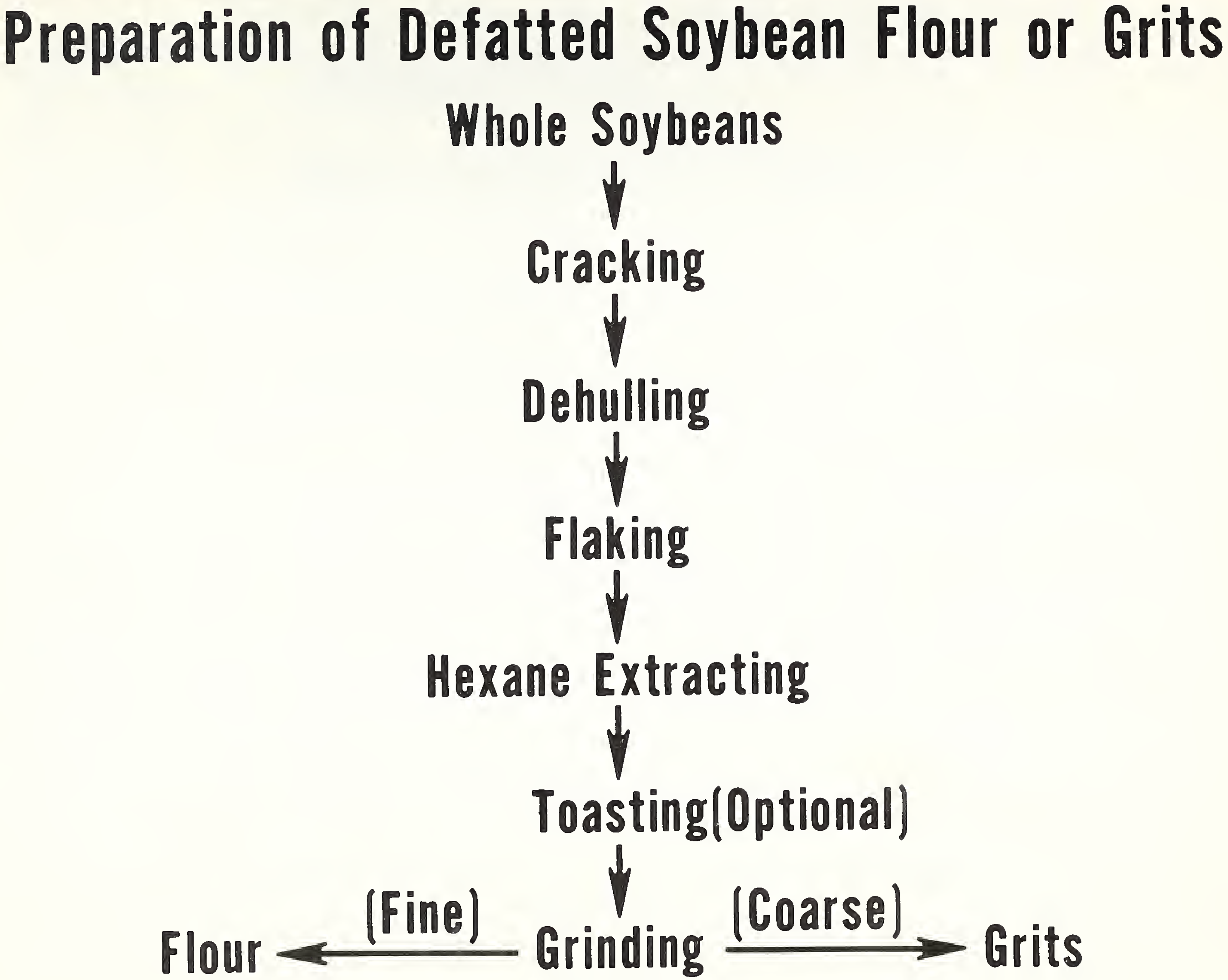

Figure 1.—PREPARATION OF DEFATTED SOYBEAN FLOUR OR GRITS.

vantages of full toasting, intermediate degrees may be desirable at times in order to retain adequate levels of functional properties since at least some of these are destroyed progressively by toasting. Thus, the particular uses to be made of the products determine the degree of toasting required. Obviously, anyone trying soybean flour or grits in various applications must be aware of this variability of products and specify the appropriate one for the tests under consideration.

Since functional properties have been mentioned several times already, I have listed some of the more important ones for soybean proteins in food systems below:

Emulsification	Ground meats Whipped toppings
Fat control	Doughnuts Ground meats
Water absorption and holding	Bread
Texture	Gravies Simulated meats
Color control	Bread

This tabulation also indicates typical uses in which each functional property is important. Some of these properties are exhibited by all of the forms of soybean protein; while others are more pronounced with one of the forms (flour, concentrate, or isolate).

Emulsifcation of fats is an important attribute of soy protein when used in ground meats and sausages. In such products, the fat-control function of soy protein retards cooking out of fat, thereby minimizing loss of juiciness and flavor. Another aspect of fat control is exhibited in the use of soy protein, for example, in doughnut and pancake mixes. Less fat is taken up during frying when the soy protein is included.

The use of soy protein products in bread can improve the waterholding properties, thereby giving better retention of freshness. Increased water absorption in the dough gives better handling characteristics.

Two rather different aspects of texture are involved in the examples listed. Thickening is a function of soy flour and concentrates in soups and gravies. The fibrous character of some simulated meats is dependent on spun fibers of isolated soy protein.

Color control in bread, as already indicated, is dependent on the bleaching action of enzymes in undenatured soy flour. On the other hand, soy flour in bread gives an enhanced and brighter color to the crust.

Other functional properties of soy proteins and other uses dependent on functional properties could be listed. The examples given above, however, should suffice to indicate the nature and importance of such properties.

Nutrition might also be considered a functional property of soybean proteins. The nutritional importance of soy protein products stems from the amino acid composition and the protein content. One approach to improving the diet is the use of soy protein products in combination with cereal products. A typical combination is soybeans and corn. The amino acid composition of the protein in soybeans complements that of corn. An indication of the relationship is given by figure 2 showing the relative proportions of some of the essential amino acids. In general, the addition of soy products to corn, for example, corn meal, brings the amino acid pattern in better agreement with the pattern of hen egg protein and at the same time gives a higher protein content than in the corn itself. This complementary and supplementary relationship also is found in combinations of other cereal products with soybean flour or protein. For this reason, considerable attention is being given to such uses of soy flour and soy protein.

Various combinations of cereals with soybean flour or soybean flakes are summarized in table 2. Since most of these have protein contents in the neighborhood of 20 percent, they would be of particular value for increasing the protein content of the diet. I am sure that many other variations in components and formulation are possible to meet the preferences and needs of different consumers.

The most widely used of these blends so far is CSM, also referred to as Blended Food Product, Formula No. 2. The designation CSM derives from the components: cornmeal (C), soy flour (S), and nonfat dry milk (M). The product presently contains 64 percent processed cornmeal (precooked), 24 percent toasted soy flour,

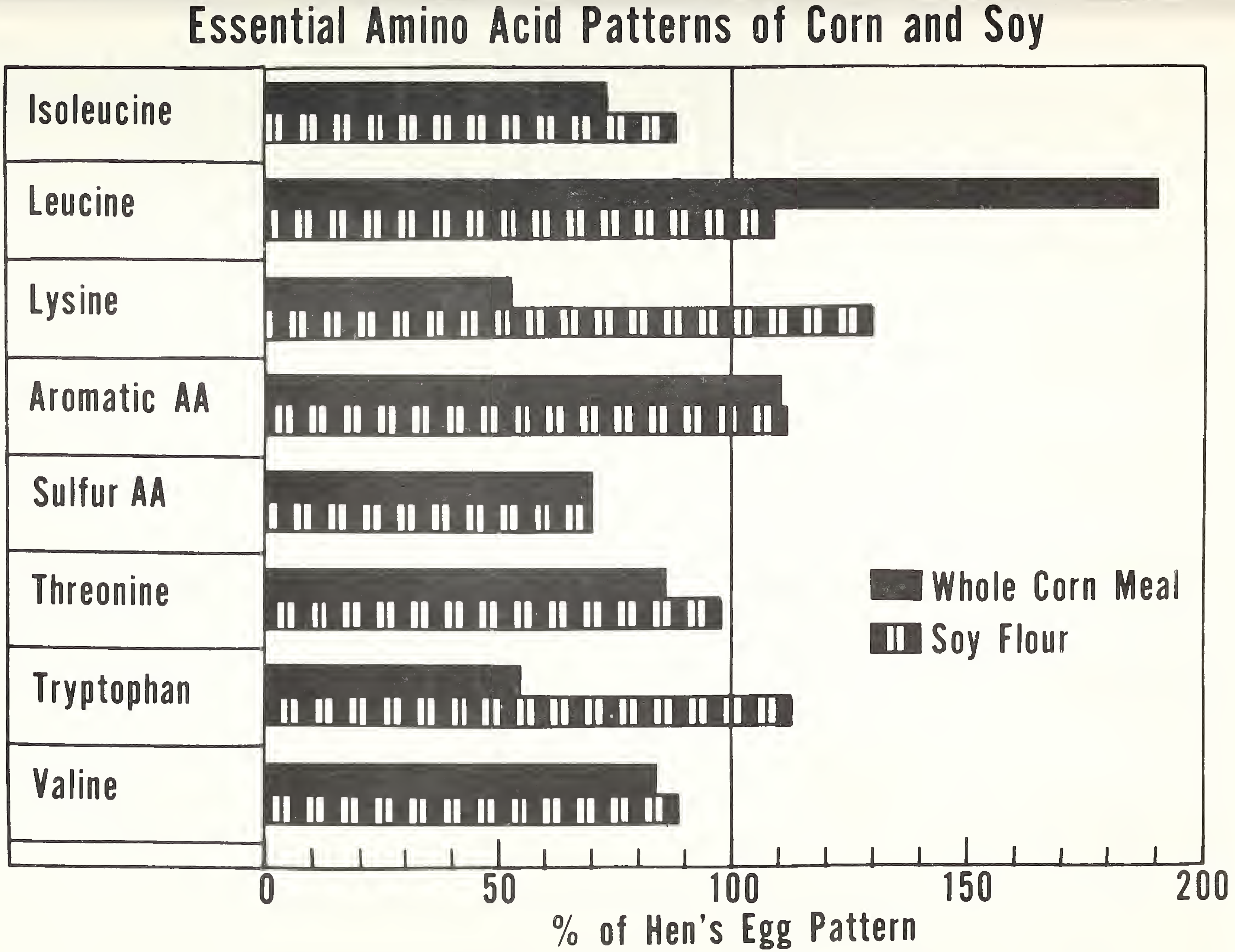

Figure 2.—A GRAPHIC COMPARISON OF THE AMOUNTS OF AMINO ACIDS PRESENT IN WHOLE CORN MEAL AND DEFATTED SOY FLOUR COMPARED WITH THE IDEAL PROTEIN (WHOLE EGG PROTEIN) AS EXPRESSED IN PERCENTAGES.

Table 2.–*Soy applications in food blends.*

Blended food	Min. protein percent[1]	Soy product used: Form	Formula percent	Type
Wheat-soy flour (WSB)	20	Flour	20	Defatted, toasted.
Wheat-soy flakes	17	Flake	15	Do
Mixed infant cereal	16.3	Flour	14	Do
Formula No. 2 (CSM)	19	Do	24	Defatted, toasted and/or full-fat, toasted.
Formula No. 1 (Ceplapro)	19	Do	24.9	Defatted, toasted.
High-protein macaroni	20	Do	30	Defatted, lightly toasted.
Corn meal-soy flour	13	Do	15	Defatted, toasted.

[1]Dry basis.

5 percent nonfat dry milk, 2 percent of a mineral-vitamin mixture (calcium, iron, zinc, iodine, Vitamin A, Vitamin D, Vitamin B_{12}, thiamine, riboflavin, niacin, pyridozine, panthothenic acid, folacin, and alpha tocopherol), and sufficient soybean oil (generally about 5 percent) to give a total fat content of 6 percent. This formulation contains a minimum of 19-percent protein, on a dry basis.

The composition of CSM is based on guidelines established by the Department of Agriculture in collaboration with the Agency for International Development and the National Institutes of Health. Initial formulations were developed by the American Corn Millers Federation and modifications were introduced by the Department of Agriculture. Purchase of CSM has been part of the Food for Peace program—the total amount from 1966 to date being over 1 billion pounds. The primary intended use is as a food supplement for children. It is prepared, for example, as a cooked gruel. However, it can be put into other food recipes to supplement the protein, vitamin, and mineral content of traditional foods.

Many variations of CSM are possible, based on modifications in the processing of the cornmeal and soy components. For example, we have developed conditions for preparing an instant CSM which gives a gruel on simple addition of cold water. Another variation is a so-called beverage-type CSM which can be used either as a beverage or as a gruel, with higher solids content than for the original formulation. The higher concentration is desirable in many instances for infant feeding.

Other products are at various stages of development. Ceplapro (also designated Blended Food Product, Formula No. 1) is produced in a ricelike form. It is a combination of corn flour, durum flour, soy flour, and supplements. Ceplapro was developed by the American Corn Millers Federation for consumers who would prefer the ricelike physical form.

Another product somewhat similar in composition but differing in physical form is a high-protein macaroni containing mainly corn flour and soy flour together with a vitamin-mineral premix. I understand that this product is ready for test marketing by General Foods Inc.

Moving in the direction of greater simplicity, we have tried mixtures of cornmeal and soy grits in such products as cornbread. Levels of commercial defatted soy flour as high as 15 percent were used in the mixture without any flavor problems. Still higher levels, such as 25 percent, were acceptable with our laboratory-prepared, full-fat soy flours.

Let us move now toward the sophisticated products. Beverages represent an intermediate level of sophistication. They are attracting attention as a convenient means of providing additional protein and other nutritional factors. Soybeans serve as one of the sources of protein in these beverages. Two commercial products which have received publicity are Vitasoy and Saci. Vitasoy is being marketed successfully in Hong Kong as a soft drink. However, it is not carbonated; soy proteins thus far have not performed satisfactorily under carbonation. In this respect soybean proteins differ from at least one fraction of cottonseed protein. Saci is being marketed in Brazil by the Coca-Cola Company, again as a noncarbonated soft drink. One philosophy behind the sale of soy beverages as soft drinks is that if people are going to buy soft drinks anyway, they may as well spend that money on something that is more nutritious because of protein and vitamin content.

Beverage-type products have received some attention in our research at the Northern Utilization Research and Development Division (NURDD). An instant beverage base has resulted from our research on extrusion cooking for the preparation of full-fat soy flour. Through the use of the proper conditions in extrusion cooking, together with further processing, our engineers have developed a dry product that is easily mixed with water to give a beverage. The favorable flavor characteristics and other properties of the full-fat soy flour permit the exercise of considerable ingenuity and variation in formulation. The one shown in table 3 is patterned after milk since milk is a standard base of reference for beverages having high nutritional quality. The formulation has been adjusted to give approximately the same fat and carbohydrate content as milk and uses the mineral and vitamin premixes which have proven satisfactory in such products as CSM. A wide range of flavoring agents can be used. Some indication of the mild flavor of the base itself is provided by our experience with addition of an artificial cream flavor. While the resulting product did not taste exactly like milk, it was considered agreeable and acceptable by those who tried it.

Table 3.—*Composition of formulated beverage base*

Item	**Percent**
Extruded full-fat soy flour	74
Hydrogenated soybean oil	15
Sucrose	7
Mineral premix	2
Vitamin-antioxidant premix	< 1
Flavoring	< 1
Salt	< 1
Emulsifier	< 1

Truly sophisticated products are represented by meat analogues based on soy proteins, developed by several companies. One reason for interest in this application has been the price differential between soybean protein and meat protein. However, a word of caution is desirable relative to the way in which this differential sometimes is presented. A typical set of figures for the cost of protein in different protein products is shown in table 4.

Table 4.—*Comparative prices of edible protein products*

Protein product	**Dollars per pound**	**Dollars per protein pound**
Beef (meat)	1.00	5.55
Milk solids (whole)	0.23	1.00
Isolated soy protein	0.35	0.40
50 Percent protein soy flour	0.07	0.14

Here we see that a pound of protein costs about $5.55 in the form of meat compared with 14 cents in the form of soy flour. However, this is hardly a fair comparison since a cup of soy flour neither looks nor tastes anything like a piece of beef. By the time you get to the place where the soy protein looks like roast beef and tastes like roast beef, you will have put considerable money into processing, formulating, and marketing. These costs go a long way toward closing the gap between the price of soybean flour and that of meat. Yet, the soy protein products still remain an economic advantage even in these early stages of commercial development when comparisons are made of products at the same stage of preparation for eating.

A better indication of the competitive position between soy protein products and meat is given by the prices of textured soy protein products shown in table 5. Two quite different classes of textured soy products are listed here. The simpler one is made from soy flour by an extrusion process. The selling prices of 31 to 40 cents a pound for plain textured soy protein and

Table 5.—*Textured soy protein products*

Price Item	**Price, cent per pound**[1]
Textured soy flour (plain)	31 to 40[2]
Textured soy flour (flavored)	45 to 110[2]
Spun fibers, soy protein isolate	[3]
Simulated cooked meat products from spun fibers	[4]

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[1] Approximate. [2] Dry.
[3] Not sold as such. [4] Below meat product

45 cents to $1.10 per pound for that with various meat flavors and other characteristics can be expected to decrease somewhat when large-scale production is attained. Products based on spun fibers from isolated protein are higher priced because of the higher price of the raw material and the more complex processing required. The final product can have the characteristics of a slice of beef, for example, instead of the ground-beef type of product prepared from textured soy flour. In considering the price of products based on spun fibers, we also must remember that they are sold as precooked products and, therefore, should be compared with meat products at a comparable stage of preparation. Simulated meats of this type are being marketed in increasing amounts to meet special dietary requirements for people who out of choice or of necessity do not eat meat. While prices can be expected to drop some as production increases, simulated meats based on spun fibers probably never will be cheap relative to the purchasing power of low-income families.

Convenience and storage stability, in addition to dietary needs, are advantages of soy protein products of the meatlike type. An example is Bac-Os marketed by General Mills. These bacon-flavored chips are made from soy protein. The product is stable on storage and ready for immediate use, for example, in salads or on baked potatoes.

This quick overview of soybeans as a food crop has touched on edible soybean oil and then looked more closely at food uses of soybean protein. I am confident that we will see continuing increase in the use of soy proteins for foods. This is an area in which industrial research has played a great role, particularly in such products as protein concentrate, protein isolate, and simulated meats. At the same time, USDA Utilization Research has had and is continuing to have an input for which I am sure we all feel a considerable degree of pride and enthusiasm.

NEW CITRUS PRODUCTS

by

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This talk can be divided roughly into two areas. The first will be a description of the new philosophy toward product development at the Florida Department of Citrus, while the second part will be a discussion of some of the actual products we are working on. Incidentally, the Florida Department of Citrus is the new name for the Florida Citrus Commission staff organization following Florida's State governmental reorganization. The Commission still exists as the governing body of the Department of Citrus.

Many of you are probably aware of the rapid growth of the Florida citrus industry in the two decades following the development of frozen concentrated orange juice. In the mid-1940's Florida was second to California among the citrus producing States of the United States. However, today Florida produces almost three times as many oranges as California, Arizona, and Texas combined, and Polk County, Fla., alone outproduces California. Florida citrus production has become so large in fact that in 1966-67, when we had our record orange crop of 145 million boxes, the tonnage of oranges alone from Florida exceeded the deciduous tree fruit production of all 50 states. Furthermore, crop size projections from the Florida Department of Citrus Economic Research Department indicate that in a few years we may well consider the record 145 million box figure of 3 years ago to be the equivalent of a bad year.

These figures are not presented in the form of a boast about how big and important our industry has become. They point up a very serious problem. The Florida Citrus Orange Juice (FCOJ) boom greatly overstimulated the production of oranges in Florida; consequently, we now are faced with large crop surpluses. Part of the problem was brought about by interests who planted enormous orange holdings as a tax writeoff. Fortunately this has been cured by legislation requiring new orange groves to be capitalized immediately rather than treated as expense as was done for many years. However, we are still faced with the consequences of 20 years of heavy grove expansion.

The Florida Department of Citrus is attacking this problem along many fronts. Obviously, one approach is to produce as many new type products as possible so that citrus can be placed in many new markets. Every possible outlet must be found and utilized to the maximum. This is the approach that interests us today, and exclusivity is one of the keys.

Over the past several years our small group working on new products had found they were severely limited by the lack of any practical means to provide exclusivity to any company that might be willing to introduce one of our new products. Companies were very reluctant to spend large sums of money to promote a product when a competitor could come in and underprice them at any time.

In November 1968, we reorganized our processing research department to create a New Food Products Research group composed of our most talented and creative people. At the same time an intensive study was launched into patent policies in use by various State governmental bodies. Over a period of several months we evolved an entirely new Department of Citrus patent policy which was finally approved by a unanimous vote of the Florida Citrus Commission, and subsequently approved by the State Attorney-General in Tallahassee. I will read to you the preamble to this policy as it expresses so well the philosophy of our new program.

> "The Department of Citrus hereby adopts the following patent policy with the declared purpose of protecting the interest of the Florida citrus industry, and maximizing returns to this industry by insuring that patentable items discovered or invented by members of the staff of the Department, or by Department staff members working cooperatively with any other party, will be used for the benefit of the Florida citrus industry only.
>
> "In practice this policy will guide and provide strong incentive to the Department's Scientific Research staff in obtaining the necessary patent protection for inventions and discoveries conceived or developed by or in cooperation with them using Department of Citrus facilities and services, and in determining the relative rights and equities of all parties concerned with regard to licensing and royalties."

In the few months that this policy has been in effect, it has resulted in the filing of patent applications on three new food products and one new food-type byproduct.

The titles of these applications in the order of their filing are:

1. Full-flavored citrus juice energy supplement.
2. Citrus seed clouding agent for beverage bases and processed products.
3. Natural citrus base.
4. High protein citrus food products.

Each of these new food products enables us to enter a market where orange juice is not now sold. For example, the "Full-Flavored Citrus Juice Energy Supplement" is a product designed for use by those engaged in strenuous physical activity and would compete in the market occupied by such products as Gatorade, Sportade, and Bulldog Punch.

Our new citrus base enables us to prepare several new types of citrus products including a *carbonated* citrus juice. To our knowledge, no natural fruit juices have been presented to the consumer in a carbonated form.

Likewise, we hope that our "High Protein Citrus Food Products" will gain us an entry into the instant breakfast market where we are not presently involved. Our citrus seed clouding agent is a possible substitute for brominated vegetable oil clouding agents which are presently in trouble with various regulatory agencies.

In terms of stimulating interest we can already say that our new program has been a rousing success. Each week at least one new company sends a delagation to discuss the citrus product area with us. The roster of companies which have visited us reads like a "Who's-Who" of the American food industry. Most of these companies prefer to keep their interests confidential so I am unable to read you the list. However, it is now public knowledge that our first pending patent, the "Full-Flavored Citrus Juice Energy Supplement" was licensed to the Pillsbury Company. This is a good example of the kind of companies we are trying to attract to our industry.

I would now like to go into the second part and talk about some of the promising products under development before our new program. A product which should have a lot of impact in the next few years is high density concentrate with essence, commonly called Hi-D. This is an example of an older product, FCOJ, improved by changing the Brix level plus addition of an entirely new product, namely orange essence. When this product is produced it will probably be marketed at a 56.6° Brix level as compared with the present FCOJ at 45° Brix, so that 6 oz. makes 32 oz. (1 quart) of juice. Eventually, we may be able to eliminate the use of cutback juice, orange essence substituting for the cutback juice. This has several advantages. First of all, a 56.6° Brix product contains more orange solids in each can and, therefore, would increase the number of oranges a housewife buys each time she purchases a can. The marketing people call this increasing the size of unit purchase and its advantage is obvious. Secondly, the use of orange essence as a flavoring material is not as costly as the use of cutback juice for this purpose, thus introducing additional economy. A third advantage of essence is that it would make it possible to pack 12 months per year, without a summer shutdown, by storing bulk concentrate and essence.

For those of you who aren't familiar with the term orange essence, this is a completely new product which has been under active development for over 10 years. The Scientific Research staff of the Florida Department of Citrus has been working on it since 1958. Orange essence is a water solution of the very aromatic principles from orange juice. It is obtained by adding columns and very efficient condensers to the juice evaporators to hold back aromatic components formerly lost in the water removed from the juice during the concentration process. Since these materials used to be lost in the waste, the essence manufacturing process is referred to as essence recovery. The term "recovered essence" is frequently used to describe the product. Its use in FCOJ gives a product somewhat more similar in flavor to fresh juice than FCOJ prepared in the normal manner. It is not a miracle ingredient which can be used to transform poorly flavored juice to juice of good flavor. However, its proper use can make a good product better.

Also, under development by the Department's staff are processes for producing a more highly colored orange juice. Many of you are aware that juice of our early oranges is more yellow and less orange than that produced later in the season. Consumer surveys have shown that a juice with a deep orange color is preferred to a yellow juice. Since addition of artificial color is not permitted by the Florida Citrus Code, a project was initiated to recover natural pigments from the peel to add-back to juice. It is hoped that the use of these natural pigments will be permitted. If recovered at a sufficiently low cost the color pigments can certainly be used to better advantage for this purpose than their present use in cattle feed. In one recent experiment enough color was obtained from 300 pounds of "pineapple" orange peel to enhance the color of 1,000 gallons of juice from a USDA point score of 37 to 38. The use of more highly colored peel would doubtlessly produce even better results.

Instant Orange Juice (IOJ), the "foam-mat" dried powdered orange juice, has been under development for about 10 years in a cooperative project between the Department of Citrus and USDA's Fruit and Vegetable Products Laboratory in Winter Haven. This product will never be sold at a lower cost than FCOJ, because FCOJ itself is the starting material. However, the drying cost is surprisingly low, being only 1 cent per 24 ounces of reconstituted juice. In the "foam-mat" process, liquid FCOJ is mixed with a foaming agent, whipped into a thick foam, and the moisture removed by passing hot air over and through it while it is spread out in a thin sheet. The resulting powder, which can be easily reconstituted into orange juice by addition of water, has the advantage of light weight which could be a significant factor when considering a product for overseas markets. IOJ consists of about 98 percent natural citrus solids and contains the vitamins and minerals of orange juice. Its chief disadvantage has been that flavor changes took place during the additional drying. However, this problem has been partly overcome by addition of flavoring essences to the powder, and the product may be on the market within a year.

An interesting new form in which powdered orange juice is being presented is orange juice tablets or "O. J. Tabs." These are prepared by compressing IOJ, into tablets which are eaten like candy. Tabs may be produced in a variety of sizes and shapes and flavor may be introduced through the addition of orange oil or essence. Being composed entirely of IOJ they also contain 98 percent orange solids, including the vitamins and minerals. Both IOJ and OJ tabs were demonstrated in the Florida Department of Citrus booth at the World Trade Fair in Cologne, Germany, in October 1969. We feel they have excellent export possibilities.

In the past 2 years a joint Department of Citrus–Citrus Experiment Station project has resulted in the development of some interesting new gel-type citrus products, namely, citrus salad gels and jellied citrus sauces. The most successful of these to date have been the salad gels which use broken or whole sections to give gelatin salad-type materials which can be prepared as either hot-processed or chilled-type products. Broken sections or both from sectionizing plants are very good in these products. They could eventually become a significant outlet. Two companies ran tests on them during the past season.

Jellied sauces, like the salad gels, can also be made as either hot-processed or chilled-type products using pulpy orange and grapefruit juices as the raw materials. A jellied orange sauce has been made which is similar to the jellied cranberry sauce now on the market, and a mint-flavored grapefruit sauce which is delicious when served with meat dishes.

The gel material used for the salad and sauce products has recently been used in another interesting application, namely, as a coating for ready-to-serve, fresh grapefruit halves. Previous attempts to produce grapefruit halves had led to a product which dried out and lost flavor in a short time and was susceptible to decay. It seemed that 5 days from preparation to consumption was about the best that could be done, and this wasn't good enough. However, it was then found that by coring the fruit, followed by filling the resultant cavity, and coating the cut surface with a grapefruit juice gel, a product could be obtained which would have a storage life of up to 2 weeks at 40° F. Over 1,000 of these grapefruit halves were prepared by the Florida Department of Citrus and Citrus Experiment Station staffs for evaluation at the National Restaurant Show and National Home Economics Meeting. Considerable interest was expressed at these meetings.

The Department of Citrus research group has also been active in trying to produce improved products using citrus sections. In the past, flavor and texture problems have prevented the marketing of good frozen grapefruit and orange sections. However, it has now been found that by using a light sugar coating and quick freezing, an acceptable product can be made. A study has just been completed where freezing was accomplished using a Freon in a machine designed and furnished by DuPont. This method shows a lot of promise.

Work has also been done on the preparation of frozen and chilled orange rings. Good products have resulted which maintain flavor and texture after several months storage. The chief roadblock to this product at present is the absence of a machine to core the fruit and prepare the rings. Hand labor would result in a very expensive product with only limited sales potential.

In addition to the regular food products and the seed clouding agent there is another interesting byproduct under development. This is a filler for meat products such as hot dogs and bologna. This byproduct made from dried juice sacs works very well for this purpose.

Returning briefly to the matter of patent policy, as we work so closely with University of Florida and USDA staff members, we are exploring the possibility of inducing both those organizations to allow their employees engaged in citrus research in Florida to participate in a patent setup similar to ours. Naturally, there are a number of hurdles to overcome but some progress is being made in this direction.

IMPROVEMENT IN VEGETABLE PRODUCTION AND PROCESSING CHARACTERISTICS THROUGH BREEDING

by

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The application of research information to increase agricultural production is the only efficient base for subsequent economic growth. Although we must keep in mind basic research on plants, a great task remains in which the breeder and other plant scientists must gather an array of results from specialized studies and apply them into useful concepts applicable to the entire living plant. The coming era of horticultural science will emphasize multilevel, complex, environmental-hereditary interactions in plants. Manipulation of many environmental components and varying germ plasm will be mandatory.

The heart of horticultural crop production is the germ plasm to which the mass of modern technology is being applied. The breeder refers to the seeds and plants used in their research and breeding as their collection of germ plasm. He is dependent upon genetic diversity for new characteristics. The early settlers of this country recognized the need for plant collections to afford a diversity in food production. Thus, many seed and seedstock were introduced into this country by them.

The development of improved horticultural cultivars must be more efficient in the future. It appears, from present trends, that plant breeders must do more research with less funds. Other industries have solved this problem through innovation and automation. In the future, plant breeders must be able to react quickly to new situations through increased breeding efficiency, especially the use of shorter breeding cycles. The use of automation in all phases of plant breeding will be mandatory. The age of computer presents the plant breeder with an exciting challenge in data acquisition and storage. The sophistication of the hardware or computers and the development of appropriate programs for plant breeding will allow for more efficient work.

Improved vegetable cultivars will be of increased importance in maintaining and improving the nutritional status of the world's population. The primary objectives of any breeding program are: (1) to provide a food to the consumer inexpensively and (2) to solve problems of production to the growers. With the emphasis on pollution and pesticidal residues in foods, I believe that a concerted effort must be made by research workers to exploit and to take advantage of germ plasm material to incorporate characters such as insect and disease resistance into new varieties. The plant breeders have already been working with problems of developing high yielding varieties adapted to mechanization. I do not believe that our so-called "task force" of plant breeders in the South is large enough to produce the necessary solution to many of our difficult problems.

I will attempt to illustrate to you what breeding for improved varieties with good processing characteristics has meant to the vegetable industry.

The sweetpotato is the leading commercial vegetable crop in the South. The first successful breeding program was initiated by Miller (11) in 1939. Through the cooperative efforts of most of the Southern States, a "Sweet Potato Collaborators Group" was organized in 1938. Research workers from as many as 26 States met annually or biannually to discuss and exchange information and conduct cooperative variety and seedling trials. In 1959 a cooperative report entitled "Twenty Years of Cooperative Sweet Potato Research" was published. This represented research from 1939 to 1959. In 1970 a second report is being prepared including 30 years of cooperative research.

The sweetpotato variety, Porto Rico, was introduced into Florida in 1908; subsequently, it spread throughout the South. This variety was largely responsible for the start and growth of this industry for the period 1920 to 1951. In the period 1939 to 1969, the Sweet Potato Collaborators Group developed 38 varieties. I doubt seriously if this industry would have survived in many States if new varieties had not been developed.

An intensive breeding program has been in progress by the Louisiana Agricultural Experiment Station since 1938. This program has been expanded severalfold since its inception. Throughout the years breeding parents have been selected. Each year new germ plasm material is entered into each of several breeding nurseries: (1) master nursery representing a germ plasm pool of all breeding parents, (2) a root-knot nematode nursery representing all resistant parents including some parents with good horticultural characteristics with multiple resistance to diseases, (3) soil rot nursery similar to number 2, and (4) a soil insect nursery having parents with resistance to a number of soil insects.

The sweetpotato, *Ipomoea batatas*, is a hexaploid with a basic number of 15 chromosomes; quantitative breeding has been followed with most characters employing in all cases possible parental lines having good horticultural and culinary qualities. We have several cultivars that produce high yields of quality roots and possess multiple disease resistance (2, 5, 7, 10) in advanced tests.

The Centennial variety (12) which was released in 1960, is the leading sweetpotato in this country. Research workers (3, 12, 13, 14, 16) have also released other varieties that have been widely grown.

Centennial (table 1) produced approximately 330 bushels of marketable roots per acre which is an increase in yield of 100 bushels over Porto Rico and other varieties. The estimated value of Centennial in increased profits over other varieties for the last 8 years is estimated at a minimum of 5 million dollars annually.Although the acreage in production has been reduced by half in later years, total production of sweetpotatoes remained the same.

This variety has moderate resistance to internal cork, a virus disease, and fusarium wilt which has eliminated these diseases as economic threats to production of sweetpotatoes. With Porto Rico, fusarium wilt was a serious soil-borne disease that frequently caused serious losses in sweetpotato production but the Centennial variety has eliminated this problem. New cultivars show promise in production and resistance to other diseases. Soil rot and root-knot nematodes are two serious disease problems in areas of sweetpotato production. Resistance to these have been incorporated into new promising seedlings. Two new cultivars, L4-73 and L4-83 have good horticultural characters and resistance to internal cork, fusarium wilt and moderate resistance to root-knot nematodes; L4-186 is also highly resistant to soil rot. Other promising lines are in advanced tests.

The sweetpotato represents a crop where an excellent job of utilization of products has resulted. Generally, most crops produce approximately 60 percent of the fleshy roots of US No. 1 grade and 40 percent of US No. 2 grade or canners. The shippers and canners have each profited by this dual system of grading and marketing. The consumer can now purchase a high quality fresh market product and a high quality canned product either as a small whole, cut or mash pack. Previously the US No. 2 grade had a depressing effect on the fresh market. The

Table 1.–*A comparison of four varieties as an average of 30 tests*

Variety	Total pigment mg./100 g.	Percent dry matter	Bushels per acre (Marketable) US No. 1	Total	Canning index
Centennial	17.4	32.2	258.1	330.4	9
Porto Rico	6.2	28.1	143.6	202.3	7
Goldrush	12.3	28.9	180.7	239.3	8
L.S.D. at 0.05	–	–	66	–	–
L.S.D. at 0.01	–	–	89	–	–

production of sweetpotato flakes has been a new product that offers promise. Another promising product is sweetpotato chips. Growers have mechanized their production to a point that it is economical in many cases to produce and market sweetpotatoes for processing only.

All sweetpotato seedlings are systematically evaluated for processing characteristics. The utility value of horticultural crops is determined by both consumer and processor preferences. These quality characteristics may be classed as: (1) sensory which included color, fragrance-odor, taste, texture, size, shape, touch, and fiber, (2) nutritional which includes vitamins, proteins, and carbohydrates, and (3) utility which includes processing quality (baking, canning, freezing, and dehydration), and storage and keeping quality. Inheritance studies (1, 9) of the characters affecting quality in sweetpotatoes show that these characteristics are associated with beta-carotene.

A second crop I wish to briefly discuss is the tomato, which is the most researched crop in the United States. It is surprising to note that a variety such as Gulf State Market in use today was developed in 1917. Some breeding work has been done on this crop in the South. From my 12 years experience working with tomatoes, I find few of the cultivars developed in more northerly latitudes acceptable for economical production of fresh market and processing fruit. The first breakthrough in varieties in Louisiana occurred in the 1960's with the release of Floralou and Floradel and more recently of Creole. The interspecific cross of *Lycopersicon esculentum* x *L. peruvianum* was made in 1935 and the gene for root-knot, *Meloidogyne incognita*, resistance was obtained. The F_1 seed had mature embryos but no endosperms and by nutrient-media culture the F_1 was grown. This genetic material has been used. In Louisiana we now have a number of promising tomato cultivars with resistance to root-knot, fusarium wilt, some resistance to TMV complex, and early blight. These cultivars possess excellent horticultural characters and produce high yield of quality fruit.

The Irish potato is another crop that well illustrates the value of breeding in the production of quality potatoes. Red LaSoda and LaRouge (15, 17), are two leading red varieties in the South. LaChipper, a high specific gravity cultivar, is among the leading chipping white varieties. These three varieties were developed by the Louisiana Agricultural Experiment Station at Louisiana State University.

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SANITATION PRACTICES IN FOOD PROCESSING

by

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I appreciate the opportunity to talk to you on a subject with which I have been associated for a number of years, not only the microbiological problems connected with the canned food industry but also those concerned with the processing of frozen citrus concentrates. The subject about which I have been asked to talk to you today—Sanitation Practices in Food Processing—is an extremely broad one. It touches upon plant design and construction, equipment, cleaning, etc. Therefore, in preparing a paper on this subject, it was necessary for me to touch briefly on certain aspects of these topics.

Considerable amount of the material which I have compiled was obtained from the citrus industry but would be applicable also to other food operations.

When one thinks of plant sanitation or the sanitation of an operation, one usually associates cleanliness with plant appearance. In other words: Is the plant clean? Is it neat, well painted, and is it being kept in good repair?

Being a sanitarian is a thankless job. It is like hitting one's head against a stone wall. The wall usually is the "red light" put up by management who usually states, "What's wrong with the place? It looks alright to me. Why the continual harp about keeping a plant clean?" One of the most timely reasons for keeping a plant clean appeared in the *Oakite News*. "Henry Ford, one of the most successful industrialists this country has ever produced, was asked what he would do if he suddenly found himself the head of a business that was failing because of excessive production costs. He quickly answered: 'The first thing would be to see if the plant was clean. It is a hundred to one that I would find it dirty. I would clean it up. There is nothing so demoralizing to personnel as a dirty shop. Such a place drives away good men and attracts bad ones."

This statement was made a generation ago but it's just as timely today. Given a choice, no one would elect to work in a dirty plant. Every plant manager and foreman wants a man who will do his job well, but, if that man is forced to work in filthy unkept surroundings the chances are his worst traits rather than his best will come to the surface. No one can be expected to give his most for a company that seemingly doesn't care about him or his personal working conditions. I repeat, "No one can be expected to give his most for a company that seemingly doesn't care about him or his personal working conditions. This was true 60 years ago and it's true today, and we venture to say will be true 60 years from now. Contented personnel produce more. There are fewer rejects. Quality is higher and costs are lower." Again. "In a clean well managed plant there are fewer rejects, quality is higher and costs are lower." Everyone of you here is concerned with costs directly or indirectly, management is continually looking for ways to cut costs, but let me say this: Costs cannot be reduced in a dirty, sloppy plant operated by discontented personnel. In other words, you can't have your cake and eat it too.

Have you ever been to Disneyland, Anaheim, Calif.? If so, maybe you obtained the same impression I did the first time I paid this fabulous place a visit. What struck me more than anything else was the cleanliness of the whole operation. The grounds were so clean that one felt as if he committed a minor offense by dropping a cigarette butt, a chewing gum or candy wrapper on the ground. In other words, cleanliness promotes cleanliness.

Sanitary Index.—The first topic I would really like to discuss is what I call sanitary index. Our sanitary index, or standards for sanitation are continually changing like a stream of water during a spring flood which has just overflowed its banks. It spreads out with great force and fans out over the countryside. People who were never concerned with flood waters are now suddenly faced with them. As the water spreads, more and more people suddenly find their feet getting wet so-to-speak. This analogy can also be applied to the food industry who are now suddenly faced with FDA's GMP's.[1] The ones that are most concerned might be looked on as the food manufacturers closest to the break in the dike; or the bank where the force is the greatest. That would be, for example, the shrimp industry and the dried milk people. As we spread out, others are now finding that they are now suddenly getting their feet wet in regard to sanitation. People who heretofore never thought much about the importance of sanitation are now faced with it.

As I stated, our sanitary standards are fluid and continually changing in direct relation to our standards of living. We now demand better sanitation in our food processing operations. What was good yesterday is not acceptable today. As an example, 75 to 100 years ago the outhouse was considered modern. It was the ultimate in design and convenience. Wouldn't it be a catastrophe if we had resisted change, and when you people took your coffee break you had to look forward to something like this? Fortunately, we now have come a long way. Food processing plants have also changed and modernized their methods of operation. Transportation has also gone through a change from the old horse and buggy to the modern jets.

Resistance to change.—We have seen how our living standards are continually changing and applying this to the food industry, one is faced with a number of obstacles. This, I call resistance to change—the desire to maintain old standards in food processing. Each and every one of you has a certain amount of built-in resistance to change. I imagine a number of you here today unconsciously resisted going from a stick shift to an automatic in purchasing a car a number of years ago. Unfortunately, this resistance to change is still with us in the food industry. Many of you perhaps have heard the remark: "I've done it this way for 30 years. Why should I now suddenly change?" I, personally, have been confronted with this statement on many occasions in the pea and corn industry where the processor was resisting changing from wood to metal equipment. In this particular case, the wood was responsible for spoilage which was occuring in his product after it had been processed and stored in the warehouse. Unfortunately, this resistance to change is something that we are going to be continually faced with. Some industries, which were once very prosperous, have now gone out of existence because of their adherence to staid old methods and their lack of foresight to change with the times.

Sanitary Codes.—Sanitary codes have been developed not only to overcome resistance to change, but primarily to have a uniform standard of design. The primary purpose was to establish criteria for manufacturers in the design, construction and installation of machinery and equipment which can readily be maintained in a clean and sanitary condition. To mention a few:

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[1] Food and Drug Administration's Good Manufacturing Practices.

1. The baking industry Sanitation Standards are concerned primarily with the design, construction, and installation of bakery machinery and equipment.
2. The National Canners Association standards for canning equipment state in part:
   (a) Canning equipment should be designed for easy cleaning, safety, and easy repair of mechanical failures.
   (b) Surfaces and areas should be readily accessible.
   (c) No wooden parts should be used.
3. The dairy industry, on the other hand, has the 3-A Standards covering equipment design, fabrication, installation, and such.
4. Of the regulatory nature are the recent GMP's, a part of which specifies plant buildings and structures shall be suitable in size, construction, and design to facilitate maintenance and sanitary operations for food processing purposes.

Plant design and construction—To have a sanitary operation, one must first have a plant that has sanitation designed into it. Along this line, I would like to mention a couple of items which have caused me a certain amount of anguish throughout the years.

The first is: Floors which should be self-draining, readily cleanable, kept clean, and in good repair. The other: Cleaning facilities which should be adequate for the operation to be performed.

This might sound facetious; but in my opinion, if we could place floor drains in the lower part of the floor we would come a long way in sanitary design of a plant. I have seen floor drains not only in the citrus industry, but in many other food industries as well where the drain is placed in the high part of the floor and the employees are required to squeegee the water to the drain. I just recently visited a new food processing plant. The floors in this particular case were perfectly level with drains spotted here and there. Water, in this particular case, had to be squeegeed to the drains; a time-consuming operation. In connection with the floors themselves, there is great need for a surface material that will stand up under acid conditions. Epoxies have been used but there is still room for improvement.

The other item, many times overlooked, is the detergent system. Plants are frequently designed without any thought given as to how the equipment is to be cleaned. The ability to keep equipment clean and sanitary is just as important as the processing operation itself. Equipment might be of sanitary design and construction but unless proper tools are provided for cleaning, it cannot be kept in this condition. This item is very important but is frequently overlooked in a large number of our food processing plants.

Equipment design and plant layout.—Likewise, I would like to touch upon equipment design. Equipment should be so designed and of such material and workmanship as to be adequately cleanable.

Holding vessels (that is, storage tanks of all sizes) should be self-draining. Unfortunately, this is not usually the case. I have seen tanks as large as 50,000-gallon capacity which could not be completely drained. Such a holding vessel is almost impossible to properly clean, and, as you can imagine, creates sanitation problems.

Manholes used on many large holding vessels should also be of sanitary design. Tanks are sometimes designed with manholes protruding from the side wall. This is an extremely insanitary type of construction. It not only creates a dead pocket but the cover is also difficult to remove. I have observed tanks as large as 50,000 gallon capacity with this type of manhole. The gasket in this particular case was a serious source of contamination.

It is highly important that the engineer and sanitarian work closely together to make sure that sanitation is being designed into the equipment or the plant itself or both.

Product pipelines—Product pipelines should be self-draining. Here again this is seldom done.

For sanitary reasons, pipes should be heli-arc welded instead of resistance welded. The first type results in a smooth surface inside the pipe in direct contrast to the latter which produces a very rough condition.

A sanitary fitting should have the ferrule properly attached to the pipe, otherwise, a crack or crevice will result. Welded connections and fittings provide areas for microbial growth which may be serious if a large number exists in a plant.

Flange connections should not be used if possible. Instead, the pipes should be either welded or a sanitary fitting used. These types of connections, when used in food product pipelines, are extremely insanitary. I noted 30 of these flanges on a 2-inch line in one plant over a distance of approximately 60 feet, and 29 on a 6-inch product line. A swab made from one of the gaskets on the 6-inch line showed a total of 16,000 organisms per square inch area when plated. In this case, product entering this piping system contained less than 10 organisms per ml. and was being recontaminated through the use of numerous pipe flanges.

Valves—Product valves should be of sanitary design. There are a number that fall in this category such as Keystone, Hills-McCanna, and the dairy sanitary stainless steel valve. However, there are still a number of insanitary valves used in the food industry. The Gate valve, for example, is extremely insanitary. To clean this valve properly, it must be completely dismantled. Valves of this type cannot be cleaned in place. A number of years ago I visited a dog food canning plant which was having trouble with heat-resistant organisms of the P.A. type which caused spoilage in their finished warehoused product. In this particular installation Gate valves were used throughout. An inspection showed the equipment to be cleaned properly, except for the Gate valves which when dismantled were found to contain maggots. When these valves were changed to a sanitary type the processor experienced no more spoilage.

Dead ends—A dead end is a space without an outlet. It is an area where product, cleaning, and sanitizing agents, or extraneous matter may be trapped, retained, or not completely displaced in normal operation or cleaning procedures. A dead end can take various forms. Dead ends are usually an outgrowth where the processor endeavors to make his plant extremely versatile. In so doing, he has pipelines available which permit him to use various processing arrangements. Consequently, the possibility exists that certain lines may not be cleaned and subsequently when they are reused they become a serious source of contamination. Another source of dead ends is where old product lines or unused lines are left in place resulting in a portion of the line creating a dead pocket.

Conveyor belts—Conveyor belts in food processing plants should be kept clean and sanitary at all times. The design of some belts leaves a lot to be desired. For example, some have wooden sides, others have an open space between the edge of the belt and the sides, allowing food particles to become trapped permitting microorganisms to grow; thus contaminating the product as it passes by. On the other hand, one might have a sanitary designed belt but neglect the roller bed on which it travels. If rollers are not operative, they will collect organic matter; thus contaminate the belt. Where practical, belts should be continually sanitized by means of chlorinated water sprays.

Preventive santiation—One can have the most modern food processing plant but unless the equipment is maintained in a sanitary condition through an effective cleaning operation, a modern installation can become an extremely insanitary operation. Such a program may be broken down into the component parts as:

1. Continuous cleaning which is necessary to maintain good appearance.
2. Intermittent type cleaning while plant is in operation or cleaning parts of the plant temporarily taken out of production for long periods to clean up properly.
3. General clean-up which occurs when a plant is completely shut down.

In order for the program to be effective, the necessary tools must be provided to accomplish the clean-up in a minimum of time with a minimum of effort. The ultimate in any cleaning is to have the operation programmed. In the not too distant future, I predict that most of our cleaning operations will be programmed. Industry will be forced to take this route due not only to the human factor one is faced with in a clean-up operation where every clean-up is different, but the difficulty in obtaining competent help and the cost of such help.

Sanitation audit—How does one determine the condition of his plant? One method is by making frequent inspections of the operation. In this regard, I like to use check lists for this purpose. It can be made a combination of sanitation and housekeeping since both go hand in hand. Various types of lists can be used. The usual practice is to develop a form for the plant involved. However, a universal form can be used if you are to cover plants producing the same type of product such as frozen citrus concentrates. Some examples follow. The first is used for checking our concentrate operations. This one was developed for Hi-C. Presently, we are working on a check sheet that will be suitable for coffee plants. This particular list is used by a large bakery.

In making checks of a plant, it is advisable to have the foreman of each department accompany the inspector. In our operation the results of the inspection are kept at plant level. It is circulated to the plant manager and Quality Assurance Supervisor and the sanitarian, if one is attached to the plant. However, if no action is obtained, a summation report is published monthly listing all insanitary items that still exist after 2 or more inspections. Top management is notified where the insanitary or poor housekeeping practices exist.

Biological approach—I have discussed the use of plant inspections as a means of determining the sanitary and/or housekeeping condition of a plant. Now I would like to discuss with you what I call the biological approach.

In the citrus industry the diacetyl test, which requires less than an hour to perform, has been developed as a rapid procedure for the detection of microbial activity in processing orange and grapefruit concentrates. The diacetyl test is a colorimetric method for the detection of diacetyl and acetylmethylcarbinol, end products of baterial growth produced in orange juice principally by the organisms belonging to the genera *Lactobacillus* and *Leuconostoc*. It is a very effective quality control tool.

Another method is the use of line checks that involves collecting samples of product from various processing operations and then plating the samples. However, line checks require 48 hours or more before the results are obtainable.

Another tool is the use of swabs. This is an effective method that can be used to determine equipment contamination. Various other methods have been developed to determine contamination on surfaces—such as the Rodac and Contact Plates.

Housekeeping—We have discussed so far the various methods that can be used to point out or detect poor sanitary practices. How does one maintain a neat and clean operation? Of course, management's attitude in this regard plays an important role. It has to create the incentive to keep the plant clean. One method is through a housekeeping contest. Each year our Citrus Division operates a contest with is a combination of both safety and good housekeeping. For your information, this is the 12th year we have carried on this program. Posters using a catchy slogan announcing the contest are placed in each plant before the start of the program. Some examples are: "STOP ACCIDENTS," "CAUTION—THINK FIRST," "GO CLEANER AND SAFER," and "WANTED—CLEANER AND SAFER PLANTS FOR '65;" and currently, "STAY SAFE—KEEP IT CLEAN IN 1970." A booklet describing the program is prepared. Incidentally, I have copies for anybody who might be interested. This booklet is given to all of our plant employees and new people when they are hired. One item which has aroused considerable interest is our SAFETY SAM Slogans. Some examples are: During the day of the plant inspection, or twice each month, a Safety Sam Slogan is posted on the bulletin boards at each plant. At the end of each review the area personnel and safety manager draws from a hat at least 10 plant employee names. The personnel manager then contacts the eligible hourly employees in the order their names were drawn from the hat. The first one to repeat the slogan word for word is awarded S&H Green Stamps redeemable at the local redemption store. If the employee is working in an inspection area receiving a perfect score (no points lost) during the current review, the award will be 5,000 S&H Green Stamps; otherwise, 3,000. Of course, the purpose of this phase of the program is to make our employees more safety minded. Naturally, we don't permit our maintenance foreman to perform such a hazardous operation.

Prizes in the form of stamps are drawn at the end of each contest period. The winning plant receives $2.00, in the equivalent of stamps, per eligible employee and the second place plant $1.00 per eligible employee. The annual cost of this plant contest is from $2,300 to $2,600–this is for two of our plants. As a result of this contest the morale of the employees, overall plant sanitation and efficiency have been improved.

For your information, I have a supply of inspection forms for anyone who might be interested.

Running a housekeeping contest is a thankless job. Everybody seems to be laying for you, especially the plant managers, if you take a point off for a housekeeping infraction in a plant.

I hope that I have been able to give you some worthwhile information concerning sanitation and housekeeping as it applies to the food industry.

Summary–Plant sanitation and housekeeping go hand in hand. Why clean? Henry Ford, one of our most successful industrialists, had a good answer. He found a clean plant had lower production costs, better employee morale than a dirty shop.

Sanitary standards are continually changing. What was good yesterday would not be acceptable today. These changes are in direct relation to our standards of living. There is an unconscious resistance to change; the desire to retain old methods, some of which may have been extremely insanitary.

A number of food industries have established sanitary codes for the design, construction, and installation of machinery and equipment.

Properly drained floors and adequate cleaning facilities are important features of plant design and construction.

Certain aspects of equipment design are mentioned including holding vessels, product pipelines, valves, and conveyor belts.

An effective cleaning program is necessary to maintain a plant in a sanitary condition. Necessary tools must be provided to accomplish the cleanup in a minimum of time with a minimum of effort.

The use of check lists to determine the sanitary condition of a plant are discussed. Several are illustrated. Bacteriological line checks, the diacetyl test in the citrus industry, and swabs and contact plates for equipment contamination are also important tools.

Good housekeeping is an important adjunct to sanitation. One company employs a Good Housekeeping/Safety Contest as a method of maintaining a safe and neat-appearing plant. The contest has resulted in improved morale of employees along with better overall plant sanitation and efficiency.

SESSION III: SPECIFIC PROBLEM AREAS IN PRODUCTION AND PROCESSING

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PESTS AND PESTICIDE RESIDUES

by

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The matter of Pests and Pesticide Residues fits well under the title of this morning's session, "Specific Problem Areas in Production and Processing." In view of the rather large amount of time and space that has been devoted recently to the general area of pesticides, by the nation's news media, I expect we can justifiably classify pesticides as a "Specific Problem Area." I am happy to meet with you this morning and briefly review some of the problems, the progress that has been made, and the prospects for this important phase of agriculture.

Why do we attempt to control pests at all? We control pests because they compete with man for survival. In matters of health, few people disagree that we should control pests. It is interesting to note that there appears to be general agreement in the control of nuisance pests. Man chooses to control plague-carrying fleas, typhus-bearing lice, and malaria or yellow fever-infected mosquitos, rather than accept the unfavorable balance of nature provided him. In matters of agricultural pest control, however, there is considerably less agreement even though the pests are controlled for essentially the same reason. There appears to be a relatively good correlation between the supplies of food, feed and fiber, and forestry products and the willingness of the nonagricultural sector to control pests. In the past man has chosen to control agricultural pests rather than accept the production, storage, and quality losses that occur when he fails. We can sincerely hope that the past rationale will prevail and that man will continue to manipulate this portion of the environment for mankind's benefit.

Contributions of pesticides have been worldwide. The National Research Council Committee on Persistent Pesticides reported that "through the use of chemicals, spectacular control of diseases caused by insect-borne pathogens has been achieved, and agricultural productivity has been increased to an unprecedented level. No adequate alternative for the use of pesticides for either of these purposes is expected in the foreseeable future."

The report of The Secretary's Commission on Pesticides and Their Relationship to Environmental Health (Mrak Report) points out in the introduction that "Our society has gained tremendous benefits from the usage of pesticides to prevent disease and to increase the production of foods and fibers. Our need to use pesticides and other pest control chemicals will continue to increase for the foreseeable future."

The report goes on to sound a warning regarding the impact of past pesticide use and the need for additional cautions in future use. These two statements do not mean that pesticides are the only weapons available to combat pests and diseases. Other methods are being used today under certain circumstances. It does mean, however, that at present and for the foreseeable future chemicals are the most effective weapons and will continue to be an essential part of our arsenal. The use of some current pesticides will no doubt decrease, some will cease to be used altogether, and some, including newly developed materials, will increase in use. Chemicals will continue to be an essential part of the integrated biological-physical-chemical pest control weapons.

Plant diseases, weeds, nematodes, and insects are a menace to agricultural production and in some instances to the direct welfare of man and his animals. The living forms, man, his animals, and plants, cannot exist in a nonmanipulated environment. Pest control is one of the major environmental manipulations mandatory for the most efficient, safe, and economical production of the necessities of life. A sometimes overlooked fact is that man and his animals are dependent upon plant and animal life as their source of energy.

Food, fiber, and forestry crops are produced in a very complex environment. More than 1,500 diseases may be caused by the approximately 50,000 species of fungi that compete for food, space, and air. About 30,000 species of weeds are distributed throughout the world. Many of these are major competitors and more than 1,800 cause serious economic crop losses each year. Of the several hundred thousand insect species, more than 10,000 of them are classified as pest insects. Truly man must maintain reasonable control of these accumulated pests if he is to survive.

Pesticide residues can and do occur on and in raw agricultural commodities as a result of direct applications of pesticides to control insects, diseases, weeds, nematodes, and lesser pests. Pesticide residues also occur on and in raw agricultural commodities where there is no record of the pesticide having been purposefully applied to the commodity.

The Food and Drug Administration, of the Department of Health, Education, and Welfare conducts a nationwide surveillance and compliance program. In this program thousands of samples are collected and analyzed. Samples of raw agricultural commodities are collected where there is no reason to believe that excessive residues are present or that pesticides have been misused. About 3 percent of the samples were found to exceed the established tolerance limits, or in the absence of established tolerances, the administrative guidelines for excessive residues. Although approximately one-half of the samples collected contained residues of pesticides, a majority of the residues were at very low levels. Over 75 percent of the individual pesticide residues found were below 0.11 part per million and 95 percent of the residues found were below 0.51 part per million. Generally, foods sampled in this program undergo further processing or preparation before consumption. The pesticide residue levels in our food supply are indeed low. Our foods are safe to eat from the standpoint of pesticide residue content.

The Department of Agriculture conducts routine surveillance programs of the meat and poultry processed in certain facilities. Part of the program involves the sampling and analysis of tissues for pesticide residues. In those instances where residues are found in the tissue samples, they are generally well below the levels established as safe for human consumption. Occasionally a sample is found that contains overtolerance amounts. When this does occur the animals or birds are removed from the market. Through another part of the program we have been successful in establishing why the residues were high in the occasional samples. Through cooperative programs we have been able to encourage corrective action, generally in the form of changes in treatment programs, to help prevent additional high residues.

In our analysis we are finding low levels of some pesticides in the tissues of birds and animals where the pesticides are not registered or recommended for use on the birds or animals. We are concerned with the source of these low-level residues. Are they the result of a misuse of the pesticides in and around the birds and animals? Is the source of these residues one of the components of the feed? Our concern is not one of food safety. We know that the levels being found are not a matter of health. Our concern is with the uncontrolled source or sources of these residues and what we and you can do to remove the source or sources.

In addition to the surveillance programs of the Food and Drug Administration and the Consumer and Marketing Service, a nationwide monitoring program is underway. The Department of Agriculture is responsible for the soils phase of the program. The Department of the Interior conducts the water portion of the monitoring study. The Department of Health, Education, and Welfare investigates the residue levels in man and in the air.

The soils portion of the coordinated study is rather extensive. Several 1-square mile study areas have been established to study the residues of agricultural pesticides mainly in the soil with lesser emphasis on crops, water, and sediment. The original study areas were established in five sections of the Mississippi Delta. At the end of the first year, adjustments were made in the program and several of the areas were deleted from the study. Later in the program (1965) study areas were included in North Dakota, Arizona, and Alabama.

As might be expected, the largest residues in soils were usually found in fields where the greatest amounts of pesticides had been used. DDT, including its degradation products, and dieldrin and endrin were most frequently found. The residue levels found in the soil were not directly related to the total usage of the particular pesticide on the soil sampled. With the exception of soil samples from orchards, the amount of pesticide found was generally equal to the amount applied during the current year. Levels found in the fall were usually higher in those cases where the pesticides were used during the growing season.

Evidence was found of movement of pesticides from the soil to the crops. In some areas, residues were found in crops grown in fields that had not been treated with the particular pesticide during the growing season. Analysis of the soil indicated that the pesticide found in the crop was present in the soil. Use records established that the pesticide had been used in the area in years previous to the current crop year. Residues of dieldrin were found in peanuts where no dieldrin had been applied to the nuts. Residues of dieldrin or endrin were found in soybeans and these residues could be associated with previous usage of the pesticide on either corn or on cotton. Analysis of finished peanut butter failed to show any measurable pesticide residues. The residues in soybeans are removed by the deodorization process during the refining of the oil. The presence of residues in the beans may partially explain some of the residues found in animal and bird tissues if sufficient residues are carried through in the cake or the meal.

Water sample analysis indicated that small amounts of pesticides were present in the ponds sampled. Evidence was found that pesticides can be carried into water sources from cropland by normal drainage or irrigation.

Analysis of sediment taken from farm ponds showed residues of DDT, and its degradation products, to be the pesticide most generally found with residues of dieldrin and endrin occurring less often. Other studies conducted along major rivers have shown that pesticide residues may be reaching our rivers in the discharges from nonrural areas. A survey of the major rivers of the United States, conducted by the Federal Water Pollution Control Administration, has established that most of our rivers contain low-level residues of pesticides. The levels found are generally in the parts per billion range or in fractions of a part per billion. The significance of these levels of residue is not fully known.

The air monitoring program has been handicapped by the lack of suitable sampling equipment. Special equipment has had to be designed, built, and tested. Sampling programs are now underway. Individual instances have been reported where pesticides have moved long distances associated with dust storms.

Pesticide residues have gone international. Several European countries have recently adopted pesticide residue laws or have updated existing regulations. Other nations are considering the adoption of national standards. Since the early 1960's international consultations have been underway regarding the establishment of acceptable international food standards, including pesticide tolerances. These consultations have been under the guidance of the Codex Alimentarius Commission.

The Codex Alimentarius Commission is an international body operating under the auspices of the United Nations and charged with the responsibility of developing and establishing international standards for food. The purpose of these food standards is to protect the consumer's health and to facilitate world trade. Any government that is a member of the Food and

Agriculture Organization or the World Health Organization may send delegates to scheduled meetings of the Codex Alimentarius Commission or any of its 17 committees. Upon the establishment of a standard the Codex Alimentarius Commission will publish the standard. Acceptance of Codex Standards by a country is strictly voluntary. Once a country accepts a standard it then agrees to abide by this standard in both its exports and imports.

The United States has a vital interest in these standards, both as an exporter and an importer. Establishment of standards, including pesticide residue tolerances, assures that levels of pesticide residues will not become a matter of trade negotiation or an artificial tariff. Unfortunately, we have situations where the presence of pesticides in raw agricultural commodities do serve as a point of negotiation and have in certain instances interfered with international trade.

To date we have been successful in establishing international tolerances on raw cereals for malathion, inorganic bromide, and hydrogen cyanide. Several additional pesticides on raw cereals and other agricultural commodities are in the final stages of consideration. Still more pesticides on other commodities are in different phases of consideration. Progress has been made in the area of international concern although admittedly slower than some would prefer.

We have briefly reviewed some of the problems and the progress that has been made. Let us for a few minutes consider what the future may have in store.

The pest problems will not decrease with time, at least not for the foreseeable future. American agriculture is rapidly becoming a system of monoculture as our farms decrease in number but increase in size. Experience tells us that as monoculture increases so will certain of the related pest problems. Earlier in my comments I indicated that some of the pesticides would disappear from the scene, other pesticides would find decreased usefulness and still other pesticides will experience marked increases in usefulness. All of these changes will be accompanied by new problems. Where pesticides disappear from use, corresponding changes in control procedures will be required. New techniques may need to be developed, or learned, in order to maintain pest control.

The replacement of one pesticide, or family of pesticides, with another group of compounds is not necessarily an easy transition. In the use of DDT for instance, certain parasite or predator insects are not harmed and thereby afford an unknown degree of control. Replacement of DDT by a nonchlorinated hydro-carbon pesticide may well remove the beneficial insect complex and thereby reduce or remove the biological control afforded by the former pesticide. The impact of such action is not known and will only be fully appreciated when such changes are made. The present day use of pesticides with relatively low mammalian toxicity may have induced a false sense of safety on the part of the user. Replacements of these compounds with more toxic compounds could well be accompanied with need for increased user awareness of the properties of the chemicals being handled.

There is a decided need for increased management of pesticides at the user level. This management is accomplished in some States by means of a "permit" system. Under this system the user is required to satisfy county officials as to the need for the pesticide available only under the "permit" system. This system is workable where the State agencies involved are adequately staffed to handle the workload.

During the current State legislative season, there have been many legislative actions proposed to further control pesticides. The adoption of a uniform State regulatory system would be helpful in establishing a nationwide system of pesticide management. Programs are underway to assist the states in the development and adoption of a model pesticide law. Additional management of pesticides at the user level may allow certain pesticides and certain pesticide use patterns to remain available to the American farmer. Better management with an accompanying reduction in environmental contamination may be the answer. Better management of pesticides will require the combined efforts of research, extension, and regulatory agencies as well as the manufacturer and, above all, the final user.

A final word regarding nonchemical control of pests. Extensive State and Federal research programs are directed toward the integrated control of pests, particularly insects. Progress has been made in these programs. Resistant varieties have been developed and released. Parasites and predators have been reared, released, and established. Successful demonstrations have been made of combined cultural, mechanical, chemical, and biological control. These programs will continue and in time provide the answers for many of our "Specific Problem Areas" in pest control.

POLLUTION AS IT RELATES TO AGRICULTURE

by

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The problems of the environment are so pervasive that almost every agency of government is necessarily concerned with one or another aspect of them. The U.S. Department of Health, Education, and Welfare (HEW) has direct responsibility for most of our national programs of *environmental control*; and, as the agency primarily concerned with the health and welfare of all citizens, it cannot help but concern itself, in one way or another, with all environmental threats to man. While my remarks will be, in the main, directed at pollution effects upon agriculture production and processing, let us not forget man's interaction with his total environment. Man is a part of, and a creature of, his environment. The naturalist, John Muir, pointed this out, in effect, back in the 19th century when he observed that "you can't pick anything up without finding that everything else in the universe is attached to it." It has taken many years and the onset of serious pollution and other critical environmental problems to bring most of us to a full realization of the natural relationships he saw so clearly.

Thus, no matter how convenient we may find it to separate and categorize air, water, and land pollution for discussion purposes—the environment we live in is itself a whole structure. Every part interacts with every other, and imbalance in any one of its overlapping and interdependent systems has far-reaching effects throughout the whole ecological system.

The story of the persistent pesticides offers us a clear and fairly simple example of this interaction—and one with which you are all familiar. Pesticides become pollutants when they, their metabolites, or degradation products remain in the environment after the desired purpose has been accomplished, or if they reach some part of the environment other than the intended target. Persistent pesticides that accumulate in a part of the environment, such as soil, water, air, or animal tissue, are of particular concern.

DDT and the other chlorinated hydrocarbons—sprayed on crops or used for mosquito control in the temperate and tropical zones—is now present throughout the environment, even in glacial snows of the polar regions and the body tissues of penguins and polar bears. Making its way into our streams, lakes, and oceans, it slows down photosynthesis in marine life—the chemical process on which all life in the sea depends. Travelling up through the food chain, it now threatens the survival of many desirable wild species. Man, of course, is at the top of this food chain, and the average American now carries about 12 parts per million of DDT in his fatty tissues.

There is no direct evidence that this concentration has an adverse effect on man—but, on the other hand, we certainly cannot assume that current levels of exposure are harmless to human health, especially when considered as part of the total chemical barrage which reaches us from all parts of the environment.

The Federal Government has recently taken action to restrict the use of DDT and to establish new mechanisms to deal with the use of other hard pesticides. Other countries and several States have banned, or are considering banning, pesticides which resist breakdown and persist in the environment as pollutants. But it will be many, many years before the earth is purged of these chemicals which man—with the best of all intentions—has injected into the environment.

The three major pollution problems—air, water, and solid wastes pollution—were recently referred to by C. C. Johnson, Jr., Administrator of the Environmental Health Service, as the "Unholy Trinity." I intend to deal to some extent with each but, as requested, provide more discussion in regard to air pollution.

WATER POLLUTION

It seems to me it is good to remind ourselves from time to time that the water we use and then discharge into our sewers is the same water that fills the clouds overhead and falls as rain. It flows into our streams and replenishes our oceans. It nourishes the land, or floods it. Everything that man himself injects into the biosphere—chemical, biological, or physical—can ultimately find its way into the earth's water.

So far as our inland waters are concerned, what goes "cruising down the river" is everything from sewage and garbage, to fertilizers, mine drainage, and uncontrolled sediment. Glen Seaborg of the Atomic Energy Commission estimates that by 1980 the United States will be producing enough waste water and heat to consume, in dry weather, all the oxygen in all 22 river basins in the Nation.

As you know, primary responsibility for water pollution control is assigned to the Department of the Interior, with the Department of HEW concerned only with health aspects of the problem. Thus, I discussed with my colleagues in the Federal Water Pollution Control Administration water pollution effects on agriculture.

One major pollution problem making waters unsuitable for irrigation purposes is that of high salinity. In the States of Kansas, Oklahoma, and Texas, spectacular examples of natural salt pollution occur. Some insight into the salt problem in the Arkansas and Red River Basins can be shown from basin studies in the period 1960 to 1962.

These findings, if expressed in terms of trainloads of salt passing key points each day, provide some insight into the amounts we are talking about. Selecting Tulsa, Okla., as a point on the Arkansas River, and assuming a boxcar holds 40 tons of salt, it would require, I'm told, a train made up of 400 boxcars each day to carry the equivalent amount of salt that flows past Tulsa in the river.

If the key point for the Red River system were located at Lake Texoma on the Texas-Oklahoma border, it would require a daily train containing 170 boxcars.

Late in 1968, a representative of the Federal Water Pollution Control Administration (FWPCA) in commenting on this said, "because of the high salinity, waters in these two basins are unusable for most municipal, industrial, and agricultural purposes."

We must recognize that water pollution occurs from three major sources, namely, municipal, industrial, and agricultural wastes . . . I would be less than forthright if I did not point out that those most difficult to control stem from such agricultural sources as animal wastes, eroded soil, fertilizers, and pesticides.

Sediment resulting from erosion of land is the greatest contributor to pollution of surface waters. The effect of this pollution by sediment is expressed in the impairment of the quality of the water and the damage caused where the sediment comes to rest.

Irrigation consumes roughly two-thirds of the water diverted to the farm. That is to say that this water is lost and does not return to the stream. Such losses occur because of evaporation and transpiration by plants.

This results in a number of changes in the remaining one-third of the water that returns to the stream. Aside from mineral concentration, we often find temperature increases, as well as changes in turbidity, color, and taste. Temperature is a critical factor as related to the natural habitat of fish.

President Nixon, in his environmental message, asked the Council on Environmental Quality to "press forward" regarding programs of both public and private intensified research "to develop new methods of reducing agricultural pollution while maintaining productivity."

Further, it should be noted that, in this same message, he proposed to greatly strengthen the Department of Interior's authority to deal with the water pollution problem, particularly in establishing and enforcing water quality standards, and has called for a new program of Federal Assistance to provide municipal sewage treatment plants, with a five-year goal for getting the program into operation throughout the nation.

SOLID WASTES

The problem of disposing of trash, garbage, and other solid wastes is monumental—both literally and figuratively.

The effluence of American affluence now totals 3.5 billion tons a year. Of this, 360 million tons are household, municipal, and industrial wastes.

Of this fantastic annual total, 190 million tons, or 4.3 pounds per person per day, are picked up by some collection agency and hauled away for disposal—to the tune of approximately $4.5 billion per year.

By 1980, it is expected that this waste collection will mount to over 340 million tons per year, or 8 pounds per person per day. It is estimated, in fact, that our solid waste is presently increasing at twice the rate of the population.

Animal waste volume from livestock and poultry production is estimated at 1.7 billion tons annually. About one-half of this amount is produced by animals in concentrated production systems. The degree of concentration and the size of individual production units are increasing rapidly. This trend permits greater efficiency in the production of animal products but also results in a need for new technology in handling and disposing of wastes in a manner that is compatible with public restrictions established to avoid pollution.

Processing of farm products for food is the principal agricultural processing industry. Almost 18,000 industrial establishments are at present engaged in this activity. In processing raw agricultural products to food, textiles, leather, pulp, paper, wood products, and industrial chemicals, there are inevitable losses of organic and inorganic matter, ranging from a small percentage of the amount processed to as much as 25 to 50 percent of the raw material entering the plant. The estimated total load of pollutants produced by agricultural processing industries is greater than that from a population of 168 million people.

Forest and crop residues serve as a reservoir of plant diseases, insects, and rodents and, if burned, contribute to air pollution. Some of these residues are useful if left on the area and properly treated. Others such as logging debris are serious problems because of the fire hazard they create or because they are hosts for diseases and insects.

The disposal of empty (solid wastes) pesticide containers add to pollution of the environment. At present, recommendations for their disposal call for burial in an area where ground or surface water will not be contaminated. This recommendation is not adequate to provide the required protection of the enviroment. Decontamination or destruction of empty containers as well as protection of persons handling them are major problems. There is need to develop means to safely recycle these containers.

The President has ordered greater emphasis on research in techniques for recycling and on development and use of packaging and other materials which will degrade after use. In doing so, he said, "pouring more and more public money into collection and disposal of whatever happens to be privately produced and discarded . . . amounts to a public subsidy of waste pollution. If we are ever truly to gain control of the problem, our goal must be broader: to reduce the volume of wastes and the difficulty of their disposal, and to encourage their constructive re-use instead."

The Environmental Health Service, Bureau of Solid Waste Management, is engaged in a program of research and planning authorized under the Solid Waste Act of 1965. We are funding research, for example, on the conversion of cellulosic wastes to protein; if the process is perfected, it could remove great amounts of paper from the waste stream. We are seeking to develop practical ways of recycling waste products, experimenting with composting techniques, and with more effective methods of incineration.

A pilot plant designed by Louisiana State University (LSU) engineers is successfully turning cellulose waste into a low cost, high protein food.

A $73,892 contract to the University subsidized the design and construction of the facility.

The development of the pilot plant followed the discovery by LSU scientists of a micro-organism that breaks down waste cellulose into a nutritious protein.

We have also awarded a $74,449 research grant to the University to isolate and identify other micro-organisms that can degrade cellulose. In addition, the research will seek to refine the processing techniques and the analysis of the protein products for digestibility and nutritional value.

Cellulose products constitute an appreciable part of the wastes from the agricultural, industrial, and municipal sectors. The development of technology to convert these wastes into protein will not only alleviate a disposal problem but, just as important, provide an essential nutritional element in the diet of man and other animals.

In the pilot facility, the cellulose waste—at present sugarcane bagasse which is abundant in this part of the country—is ground, chemically treated and sterilized, and fed into a fermenter, where the micro-organisms degrade and metabolize the cellulose.

The micro-organisms, when dried, contain about 50 percent crude protein. This edible end product—a single-cell protein—is straw-colored and has the texture of rough flour.

Clayton D. Callihan, the LSU Project Director for both the pilot plant and the research effort, explains that micro-organisms are far more efficient than livestock in converting cellulose matter into protein. A young pig, for example, doubles its weight in 2 weeks; a yeast cell takes only 2 hours.

The LSU plant is capable of producing some 50 pounds of the single-cell protein a day from 250 pounds of feed, or bagasse. Hopefully, the system can be readily adapted for other cellulose wastes such as grass, hay, cornstalks, cotton vine, wood chips, and newspapers.

The cost of producing pure protein by this process should be competitive with producing soybean flour at about 14 cents per pound or cornmeal at about 10 cents per pound and is estimated to be cheaper than protein derived from petroleum.

The LSU plant is located in Bay St. Louis, Miss., at the National Aeronautics and Space Administration's Mississippi Test Facility, which has made space and utilities available to the University.

AIR POLLUTION

The third in our "Unholy Trinity" is air pollution—as the President said in his environmental message to Congress, "Air is our most vital resource, and its pollution is our most serious environmental problem."

Air pollution is a threat to our natural habitat, the true dimensions of which we are just beginning to understand. The growing toxic burden of the atmosphere threatens both man and agriculture with striking similarity.

In terms of total economic losses, the contamination of the air is estimated to cost this country billions of dollars a year through injury to vegetation and livestock, corrosion and soiling of materials and structures, depression of property values, and interference with ground and air transportation. Losses to agriculture alone—considering injury, growth suppression, and quality changes—were recently estimated by the National Academy of Sciences to exceed $325 million annually in this country, not including damage to ornamental plants.

Of greater significance are the adverse effects of air pollution on human health. Here we are concerned not only with the threat of severe air pollution episodes capable of causing acute and sudden illness and death, but also with the hazards of prolonged breathing for months and years of the lower concentrations of air contaminants which are common in many American communities.

A growing body of scientific evidence indicates that exposure to ordinary levels of air pollution adversely affects the health of many people and is associated with the occurrence and worsening of chronic respiratory diseases and with the premature death of aged and ailing persons.

Just as there have been disastrous episodes of air pollution on human health, there have also been vegetation disasters.

The most dramatic destruction of vegetation by air pollution has taken place in the vicinity of smelters discharging large amounts of sulfur pollution into the atmosphere. In 1910 and 1911 all of the major tree species in a 5 to 8 mile radius from a smelter at Anaconda, Mont., were dead or dying. In the vicinity of the Trail, British Columbia smelter, which in 1929 emitted an average of 18,000 tons of sulfur pollution per month, plant injury was observed as far as 52 miles from the smelter. Sixty to 100 percent injury to Douglas fir, ponderosa pine, and forest shrubs occurred as far as 30 miles from the smelter in a river valley. Even though control devices were installed in 1934, by 1936 more than 80 percent of the pines that were alive in the valley had no cones.

These plant disasters are disturbing. But even more disturbing is the fact that at sulfur pollution levels routinely observed in some of our cities, many plants suffer a chronic injury frequently described as early aging. Generally, the plants most sensitive to sulfur pollution are those with leaves having high physiological activity—plants such as alfalfa, the grains, and cotton. Plants with a heavy waxy leaf such as citrus and privet are most resistant to sulfur pollution. High light intensity—especially in the morning hours—high relative humidity, adequate moisture supply, and moderate temperature—ironically, all those things which cause the plant to thrive—predispose the plant to injury.

Another pollutant that produces a characteristic injury pattern on plants is fluoride, which is emitted during the industrial processing of fertilizers, aluminum, and steel, for examples. The sensitivity of different plants to damage by fluoride varies greatly. Some plants can accumulate very high concentrations of fluoride and show no injury, whereas other plants, such as gladiolus, can accumulate injurious amounts from an atmosphere that contains only traces of fluoride.

The great economic significance of plant damage from ozone, the principal photochemical oxidant, was not recognized until as recently as 1958, when it was found in California that lesions in grape leaves could be produced by a 3-hour fumigation to as little as half a part of ozone per million parts of air. Tobacco, too, is sensitive to ozone—about one-tenth of a part per million— and tobacco plants are increasingly used to detect ozone. Ozone is now recognized as a major threat to leafy vegetables, field and forage crops, shrubs, fruit and forest trees—particularly conifers.

Ozone offers an example of the similarity of pollutant damage to both plants and animals through the same basic chemical processes. Studies show that ozone oxidizes sulphydral groups in enzyme and other components of plant cells to inhibit plant metabolism and cause cells to leak their contents. Ozone also reacts with components of the lung tissue of mammals to alter cell-wall permeability and to lead to pulmonary edema. Ozone breaks down the elements in green plants (chloroplasts) which carry on photosynthesis and, similarly, damages human red blood cells by breaking down unsaturated fatty acids in cell membranes. As with other pollutants, the degree of reversibility or irreversibility of the effects of ozone depends upon the length and concentration of exposure in both plants and man.

PAN, peroxyacetylnitrate, another of the oxidants in photochemical smog, is extremely toxic to many field and vegetable crops as well as to several ornamentals. Woody shrubs and trees and many field and vegetable crops are relatively resistant to PAN.

Under controlled conditions, automobile exhaust exposed to ultraviolet light—simulating photochemical smog conditions—has produced characteristic smog injury in plants. Some of the injuries were attributable to ozone and PAN; others to nitrogen dioxide.

Still other injury patterns indicate that irradiated auto exhaust contains other unidentified pollutants harmful to plants. Most of these artificially induced damages have been seen in the field.

Photochemical smog has caused a serious decline in citrus and other important crops in California, but, of course, smog is no longer confined to that area. Smog damage has now been reported in 27 States, the District of Columbia, Canada, and Mexico. Along the entire eastern seaboard from Boston to Washington, D. C., smog now causes agricultural losses comparable to those in Southern California. These same damaging pollutants are to be found beyond the Americas in such places as Australia, western Europe, and eastern Asia.

The visible effects of most of the common toxicants are fairly well known. A competent observer in the field usually has no difficulty in identifying the necrotic lesions that sulfur oxides or fluorides induce on plant leaves. The injury patterns produced by ozone and PAN are not difficult to distinguish. Scientists also have considerable knowledge of the cellular breakdown which takes place within leaves.

Knowledge is much less complete in regard to the possible effects of air pollutants on such matters as the growth, yield, nutritional quality, and survival of plants. We do know that severe leaf injuries by pollutants will affect growth and perhaps survival of trees, which takes repeated exposures year after year. There is reasonable evidence that oxidants or fluorides, even at levels that do not mark the foliage, may significantly reduce growth rate and fruit quality in some cases.

The entire analysis of the effects of air pollution in plants is complicated by two important influences—genetics and environment. As for genetics, different species are expected to respond differently to air pollution, but the variations within species are often just as great as the differences between species. As for environment, such factors as rainfall, temperature, wind, nutrition, soil moisture, and management practices all have their different effects. For example, it appears that much less oxidant is required to damage plants in the humid East than in the arid West, but this effect may derive in part from an interaction between environment and genetics.

In addition to all this, the pollutants themselves interact with each other in the atmosphere and also interfere with each other's effects within the plant, so that nontoxic levels of sulfur dioxide greatly enhance the toxic effects of ozone. Similarly, the damaging effects of sulfur oxides on man are enhanced and aggravated by the interaction of these oxides with particulate material.

All this demonstrates the complex nature of the effects of air pollution on agriculture, and, at the same time, illustrates the similarity of the threat that air pollution poses to all things which depend upon the air for life. This threat is reflected in three levels of effects of air pollution: (1) the immediately and easily discernible effects from high concentrations of contaminants, (2) the more slowly developing chronic effects from routine concentrations over longer periods of time of which we are now becoming aware, and (3) the long range, genetic effects about which we can only make some educated guesses.

Although there will be a continuing effort to increase our understanding of the nature of air pollution and to improve the methods and techniques for its control, much can be done today. The severity of existing air pollution problems requires the reduction of air pollution from existing sources.

In his message on the environment, President Nixon has proposed to give the Department of Health, Education, and Welfare authority to set *uniform Federal standards* for air quality throughout the nation, the States being responsible for enforcing these standards in accordance with approved abatement plans. Federal emission standards would also be established for specific pollutants from stationary sources that are hazardous to health, and for certain classes of new facilities that could be major polluters. And our enforcement procedures would be strengthened.

MECHANICAL HARVESTING OF SWEETPOTATOES IN LOUISIANA

by

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Sweetpotatoes constitute the most important vegetable crop in the South and are second only to Irish potatoes as the most important vegetable crop grown in the United States. The yearly crop value is estimated to be in excess of 100 million dollars. Sweetpotatoes have also been noted for requiring more labor for growing and handling than most other similar crops. As long as farm labor was plentiful, no great effort was made to mechanize. However, with the present high price and scarcity of farm labor, engineers have been working towards developing machinery to replace hand labor in all operations required in growing and handling of sweetpotatoes.

Field harvesting and handling have required more labor than any other operation in growing sweetpotatoes. Until very recently, most of the potatoes were dug with a plow or middle buster. Tests show that 20 percent of the marketable potatoes are left in the ground when plow or middle buster is used as compared with use of a standard rod-link chain mechanical sweetpotato digger. Also, a mechanical digger reduces the time required for gathering and field grading by about 40 percent as compared with those of a plow or middle buster. Even the farmers with small acreage in sweetpotatoes can justifiably use one of the small tractor mounted or pull type diggers, as the savings in potatoes and labor will quickly pay for its cost. Tests indicate that when no field grading is done approximately 25 man hours per acre are required to gather and crate potatoes, while as many as 50 man hours per acre may be required when field grading. One disadvantage of field grading is that the loose manner in which it is usually conducted allows the use of unqualified graders in the field, resulting in what can amount to a serious loss to the farmer.

The average sweetpotato farmer has two outlets for his crop. The best grade is sold to fresh market packers and the lower grades, according to size, are sold to the canning plants. Some farmers sell their entire crop to the canning plants. In some cases, the manager of a canning plant will contract with a farmer for his entire crop. Contracts between the farmer and operators of canning plants are becoming increasingly popular. It is felt that this is the only manner that a stabilized processing production can be achieved.

A survey made in the 1963-1964 season showed that approximately 80 percent of the sweetpotatoes crop was sold to the fresh market and only 20 percent was processed. Since that time, the percent being processed has steadily increased. In Louisiana, the percentage of the sweetpotatoes processed last season was approximately 65 percent, and the rate has been increasing at about 2.5 percent per year. Even though the larger percentage of the sweetpotato crop is processed, they are generally dug as though all of the potatoes are to be sold on the fresh market. This is because the potatoes processed are those that are not sold on the fresh market. Harvesting for the fresh market requires much more careful handling and labor than necessary for potatoes that are to be processed, thereby penalizing the farmer for that part of his crop which he sells to the processor.

Most of the present harvesters that are used are only one step ahead of the method of digging and dropping the potatoes back on the row for field grading. This type of harvester eliminates the practice of depositing the potatoes back on the ground after digging. Grading, to a large extent, is done on the harvester. To justify this type of machine, it should substantially reduce the labor required for harvesting as compared with the older methods. Since more emphasis is placed on quality each year, bruising and abrasions must be kept to a minimum for fresh market potatoes.

Several types of harvesters that meet these requirements are now being manufactured and used. In operation, the potatoes are lifted from the row by a digger shovel and elevated by a rod-link chain that is agitated to separate most of the soil from the potatoes. After a short elevation, the chain forms a grading table where graders select the potatoes by grades and place them in wire bound crates or hampers holding 50 pounds.

The power for operating the elevating shaker chain is furnished by the tractor pulling the harvester. This harvester can operate at a speed of about 1 mile per hour or more depending upon the yield and requires from 10 to 12 men. By using this type of machine, the farmer is able to obtain and use a better quality of field laborer and reduce the cost of harvesting and handling potatoes to about 20 cents per 100 pounds, or at about a 20-percent reduction, as compared with the old method of grading on the ground in the field. Usually a frame is built over the harvester and covered with a tarpaulin which serves to provide shade for the laborers and also protects the potatoes from the sun.

A survey revealed that potatoes harvested using this type of mechanical harvester showed much less bruising than those dug with a regular digger which dropped the sweet potatoes back on the ground and then crated them in the field.

The processing plants want to receive the sweetpotatoes in pallet boxes holding about 1500 pounds. To speed up transferring of the potatoes to be canned from the crates to the pallet boxes, some farmers place pallet boxes on each side of the harvester as it is backed up to the truck. While the fresh market crates are being transferred to the truck, the crates containing the potatoes to be processed are dumped into the pallet boxes and the empty crates placed back on the harvester. Some farmers have modified this type of crate harvester by mounting one pallet bin on each side of the grader-conveyor at the rear of the harvester to hold the potatoes that are to processed. A fork lift mounted on a farm tractor loads the pallet boxes on a truck or farm wagon for transporting them to the canning plant. The use of pallet boxes in place of crates for transporting potatoes to the canning plant has resulted in a substantial savings to the farmer in crate life cost.

Farmers who plan on using any type of harvester should have as long a row as conveniently possible, 600 to 700 feet long or more, and turn rows wide enough to turn the machine from one row into another without having to back up before getting started again in the new row.

When any of the presently used mechanical harvesters is used for digging sweetpotatoes, the vines should be removed before digging. Many tests have been conducted to determine the most suitable and economical implement to accomplish this task. The pasture clipper type mower adapted with gage wheels or slides that fit the sweetpotato rows was found to be the most economical and suitable for this purpose. The soil should cover the potatoes from 1 or 2 inches to give the best results for cutting the vines and not the potatoes. Disc hillers are usually attached to the front cultivator standards of the tractor to bar-off each side of the row and, at the same time, cut the vines. This practice is highly recommended as it improves the operation of the harvesting machine since the portion of the row to be dug is cleared of all vines. It also decreases the amount of soil that the harvester will have to handle. A flail type of chopper with flails contoured to fit the row has been used for removing the vines. While this machine is satisfactory, the rotary mower type does a better job, consumes less power, and is lower in cost.

As previously pointed out, most farmers sell sweetpotatoes to both the fresh market and processing plants. The major volume is going to the processing plants and this trend is increasing each year. If this trend continues to increase, a time will come when the sweetpotatoes sold on the fresh market will be a small percentage of the crop harvested. However, at present a farmer needs a harvester that will harvest his potatoes economically enough to enable him to profitably sell most of his crop to the processing plants and at the same time harvest gently enough to enable him to select his top grade potatoes for the fresh market if he so desires. A harvester to meet these requirements was designed, built, and tested at Louisiana State University in 1967. Modifications have been made to this harvester during field testing for the past two seasons. The harvester basically consists of a lifting blade and a rod-link elevating chain which is agitated. Most of the soil is sifted from the potatoes as they are elevated. A horizontal rubber belt conveyor forms a grading table, and the sweetpotatoes and remaining trash are moved along by the belt to the rear of the harvester. Workmen pick the potatoes from the belt and drop them into a cone hopper located under the belt conveyor. This hopper extends 9 inches over each side of the conveyor belt to allow potatoes to be dropped into the hopper as they are selected from the belt. Trash, and such, remains on the belt and are conveyed to the rear of the harvester where they are dropped onto the row. The bottom of the hopper converges to a cross-chain elevator that carries the potatoes from the hopper and elevates them enough to deposit the potatoes into bulk pallet bins on a farm wagon or truck being pulled beside the harvester. The side elevator is controlled by a clutch located on the harvester. This is a distinct advantage when starting into a row as it allows the harvester to begin operating before the wagon with the pallet bins can be maneuvered into position. The potatoes can be stored in the hopper until the pallet bins are in position.

Since only the desirable material is removed from the conveyor-grader belt, this harvester can operate in dry weather when the soil becomes very hard and cloddy. It is also an advantage when damp spots are encountered in the field where the grass is quite thick or potatoes spoiled. This trashy material is merely carried along the conveyor-grading belt and deposited back onto the row.

During the 1969 season, a large two row bulk type Irish potato harvester was tested for harvesting sweetpotatoes that were to be processed. The machine consisted of the conventional digger shovel for lifting the potatoes from the row. However, this shovel covered two 40 inch rows. The chain-link elevators were agitated to separate the soil from the potatoes while they were being conveyed to a single 30 inch wide cross-chain conveyor and to a side delivery elevator which deposited the potatoes into pallet bins located on a farm wagon or truck pulled beside the harvest. The vines were not removed before digging.

For handling the vines, this harvester had a wide spaced (6 inches) link-chain running above the digger elevator-conveyor chain. The function of this top chain is to grab the vines as the potatoes are dug. The potatoes would then hang by the vines from this top chain. In this manner the potatoes are conveyed to a snapper roller which snaps the potatoes from the vines and drops them onto the bottom chain conveyor which empties onto the side elevator. The vines are then dropped on the row at the rear of the harvester. Since this vine chain was developed for Irish potatoes, the 6-inch spacing was not wide enough to prevent long sweetpotatoes from being held on the chain and discarded along with the vines. Approximately 40 bushels per acre were lost in this manner. Wider spread links in the chain (perhaps 7 inches) would help prevent this loss, but too wide a spacing would decrease the vine holding ability. It was necessary to have 6 men on the harvester to remove trash, such as stringy roots, and clods of soil, that may be left on the conveyor when depositing the potatoes onto the side elevator which empties into the pallet bins. It was impossible for the men to remove all of the trash when the harvester dug at a rate of 1 acre per hour in potatoes yielding 500 bushels per acre. Consequently, trash with the potatoes amounted to 24 percent. The processors would like this not to exceed 10 percent. The processor pays the farmer for only the net weight of potatoes. To attempt to reduce this trash percentage, the vines were removed from the row before digging as was done for other harvesters. This reduced the trash by 5 to 10 percent, but slowed down the operation of the harvester by 30 percent because the increase of labor required to detach the potatoes from the crown root clusters, a job that was previously done by the snapper roll.

When the soil condition was right, potatoes could be harvested with this machine for a labor cost of about 4 cents per 100 pounds of potatoes at a rate of approximately 25,000 pounds per hour. Men were paid $1.30 per hour.

If the soil became very dry, clods resulted when digging. The six workmen on the harvester could not remove these clods at the operating rate of the machine. This harvester cannot be used in soil that tends to clod during a dry spell. In Louisiana, our dry spells occur during the months of August, September, and October, which are the months that sweetpotatoes are harvested. This type of harvester cannot be used where the farmer wants to save his No. 1 potatoes for fresh market because of excessive bruising by rough handling. In addition, there is no place on the machine to select or store potatoes removed or both for this purpose.

In summary, for the present and immediate future, farmers are going to want to sell at least their top grade No. 1 sweetpotatoes on the fresh market, even though most of their crop will go to a processing plant. Therefore, a suitable harvester is one that will harvest the potatoes gently enough so as not to bruise the potatoes for fresh market sale, but one that will harvest them in bulk, economically enough to enable the farmer to realize a profit on the bulk of his crop that goes to the processing plant.

To those farmers who are selling their entire crop to a processing plant, the large, completely bulk type harvester is the most economical to use, provided the soil is mellow enough to sift out during digging and does not become cloddy if a dry spell occurs during the harvest season.

For the sweetpotatoes that are to be sold on the fresh market, a more suitable container than the wooden wire-bound crate should be used for handling and storage. This rough, flimsy, wood container causes more damage to the potatoes during handling than any other operation in harvesting and handling. With the increased use of fork lifts on the farm, pallet bins can now be used for handling and storage of potatoes on the farm. Pallet bins of approximately one-half the depth of the regular size have been tested as a storage container and have proved very satisfactory.

MARKETING PANEL

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PROGRESS AND PROSPECTS IN RICE MARKETING RESEARCH

by

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As with production, efficiency in marketing is also important to the maintenance of a viable rice industry in the South. Indeed, for some special uses marketing costs accounts for more than 90 percent of the consumer's dollar. These costs often help sell more rice, however, and at a good price. The pertinent problem then is not necessarily how to minimize costs but what marketing job to do and how to do it most efficiently.

Over the years, the United States produces about 100 million hundred-weight of rough rice annually on about 2 million acres, nearly all of which is in Arkansas, Louisiana, Mississippi, Texas and California. One-third of the crop is used domestically, one-fourth of which is utilized for seed and brewing. The importance of exports to the industry is thus obvious and deserves special attention in a consideration of rice marketing in the United States.

About one-half of the rice exported is for dollars normally needing a subsidy to compete in world trade. It does earn about $100 million in foreign exchange, however, or about a half percent of the total earned by the Nation. Other exports move under various government programs, earning relatively little foreign exchange, but allowing recipient countries to concentrate on other economic activities. Presumably, they will eventually become good customers for United States rice and other products as did Europe following the Marshall Plan after World War II. These, along with others, such as the storage and price support program, and with acreage controls, constitute some of the more important tools for helping United States rice compete for markets with other production areas and other foods. The choice of which tools to emphasize depends on the world situation at a given time, but the right choices are important in maintaining a share of the market. Although the United States accounts for only about 2 percent of the world's production of rice, it usually accounts for 15 to 20 percent of world trade in it.

There is no International Rice Agreement as with wheat but it may be surmised that the United States uses its position in rice in an attempt to help stabilize world prices. In 1957, for example, China which is normally a large exporter of rice, exported none. The United States with nearly a whole crop in storage at the time, exported it and succeeded in keeping world prices at a relatively stable level. Large importers, such as Malaysia, Indonesia, India, Ceylon, and others, were thus spared the agony of finding enough foreign exchange to purchase the rice needed. On the other hand, for countries such as Thailand, Burma, South Vietnam, and Cambodia, which normally export large quantities of rice, the United States storage, acreage control, and other programs keep rice off world markets in certain years enhancing rice prices and enabling those countries to earn foreign exchange which they depend upon from rice.

Many of these countries also depend largely, in effect, on taxing imports, or exports, of rice to obtain funds for government operations. Relatively high or low rice prices could adversely affect the dependability of obtaining funds in this manner and lead them into economic and political problems.

In the past, the pattern has been for economists to react or evaluate the Secretary of Agriculture's staff economists' proposals for changing marketing programs as changes became necessary. For example, a 1967 analysis of the cost per calorie of exporting rice was instrumental in warding off a proposed reduction in acreage or other action generally considered unfavorable by the industry. In the future, marketing research must evaluate alternatives in advance of such a crisis. It must evaluate not only existing alternatives but propose new and imaginative ones. Marketing orders, marketing boards and more subtle means, such as credit, must be studied as possible means of enhancing trade.

In recent years, some importing countries have copied parts of our marketing systems and devised incentives and barriers to trade of their own. These programs, and prices projected therefrom, have doubtless aided them to adopt the technology needed to increase production, though much of the credit for increased production is often given to the technological advances themselves and to good weather. Their taxpayers also object, however, canceling out whatever advantage might have been hoped in this respect.

Though government programs are important most rice marketing research has been directed at the private sector of the industry. Large scale specialized operations have led the United States industry to probably the most efficient marketing in history. Yet, compared with other grains, the domestic industry must be at least 100 years behind in its marketing effort in some respects. The opportunities for further marketing effectiveness is thus great.

The number of milling operations in the United States has become very small and is likely to become smaller but those that remain operate a longer season, making more efficient use of facilities and labor. They are also larger which also generally leads to physical efficiencies. Further horizontal and vertical integration of the industry will continue to minimize procurement, transportation, and selling cost, and will lower the investment requirements for the total operation. Studies on mergers, leases, contracts, pools, exclusive selling agents, cooperatives, and other arrangements are needed to determine if these developments are desirable and if so, how to help bring them about.

Market segmentation can also be more easily achieved as the industry consolidates. Railroads haul sand for anything they can obtain over "out of pocket cost," resulting in a lower average cost for transporting more valuable commodities even though sand does not pay its share of full costs. Likewise, the rice industry could charge those uses and geographical areas which will pay more one thing and others such as brewers with a more elastic demand a lower price. In these days of convenience foods and rising per capita income in certain importing countries the possibilities for market segmentation are almost limitless for the quality of rice grown in the United States and other potential qualities that could be developed.

Quality determination and the pricing system have never been very satisfactory for rough rice. Farmers will not sell on and buyers will not buy on government grades. Rather, a large part of the industry is still relying on the awkward system of selling by auction with ownership identity of lots preserved far into the marketing system. Other awkward trading customs also prevail. In other grains where quality determinations are readily accepted, growers immediately and clearly know how much they lose for damage, foreign material, and other factors. Deficiencies in this matter also contribute to the lack of organized futures markets for rice. Such markets, which are available to other grains, enable better price communications and provide a form of readily available price insurance to growers, warehousemen, processors, financial institutions, and others. Solving the problem of proper quality determination and pricing would considerably enhance the prospects for further consolidation and industry efficiency.

To summarize, the prospects for effective marketing research may be classified into two broad areas. One deals with improving government programs. The other deals with problems facing the private sector. Both offer considerable opportunity for helping the industry maintain its competitive position.

MARKETING OF VEGETABLE PRODUCTS

by

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Vegetable marketers today are faced with a problem. Total vegetable sales are growing very slowly. In fact, recent USDA information showed vegetable sales over the past 10 years have grown only about as fast as the population.

But there are some bright spots. Per capita consumption of frozen vegetables has grown over 42 percent in the past 10 years. Over this same period, canned vegetables have grown only slightly and fresh vegetables consumption actually declined.

	Vegetable sales	10-year growth in per capita consumption
	Percent	*Percent*
Fresh	62	– 6
Canned	32	+16
Frozen	6	+ 42

This reflects several demographic and psychographic trends. First, there is a greater disposable income; second, a greater desire for convenience foods; third, greater number of vegetable varieties available (especially in terms of combinations of vegetables); and lastly, and somewhat related, there has been an increase in taste sophistication.

These trends are also reflected by the pattern of growth (both past and projected) within the frozen vegetable category. Prepared vegetables (vegetables with sauces or seasonings) grew at almost twice the rate of regular vegetables during the past 5 years, and the difference in growth rates in the future is expected to be even more significant.

Frozen vegetable trends

	Annual growth rate	
	Last 5 years	Next 5 years
	Percent	*Percent*
Regular vegetables	+4	+ 2
Prepared vegetables	+7	+10

The message to the vegetable marketer, we think, is clear – concentrate marketing efforts on frozen prepared vegetables. This is true not only because of the consumer trends we have just mentioned, but also because it reflects the dynamics of the vegetable processing business.

The ingenuity of the American farmer is showing up in larger and larger crops. Yet overheads and labor costs are continually increasing, requiring higher and higher product selling prices. The answer, again, seems to lie in higher priced, higher margin prepared vegetable items which can satisfy changing consumer tastes.

Let's take an example of how we would apply this approach to a product grown in the South–zucchini squash. We have been reasonably successful in freezing and selling both summer squash and zucchini squash in sliced form. However, recently, we developed a concept which had even greater consumer appeal . . . we called it International Style Vegetables . . . five vegetables, each reflecting the culinary style of a particular country. Each was a unique blend of ingredients combined with a special sauce. Two varieties used zucchini as an ingredient: Spanish vegetable medley (zucchini, carrots, and pearl

	Total frozen vegetable sales					
	1965 *Percent*	*1966* *Percent*	*1967* *Percent*	*1968* *Percent*	*1969* *Percent*	*Est.* *1970* *Percent*
Boilable bags	7	9	9	8	8	7
Large size packages	17	20	21	23	24	25

onions) and Danish style vegetables (zuchinni, carrots, peas, cabbage, celery). Satisfaction of consumer needs in this case has enabled us to triple the amount of squash we sell and to realize even higher margins.

Packaging trends—The majority of product sold to date is still in the form of 9 or 10 oz. packages. Boilable bags (normally butter sauce) were introduced in 1963 and 1964 and sold rapidly. But recently these bags have leveled off and actually declined to a point where they represent only 7 percent of total vegetable sales. Large size packages of vegetables without sauces on the other hand have continued to grow, possibly because of perceived economies and greater flexibility in use. They now represent about 25 percent of total frozen vegetable sales.

Item trends—Below is a summary of per capita consumption trends for both total vegetables and for frozen vegetables. On a total basis, the only items that have shown sustained growth are broccoli and corn. These items also show up in the frozen trends together with carrots and the "all other" category which probably represents the growth of new items. Cob corn provides an interesting example of how the vegetable marketer has taken a product which previously had been consumed on a fresh basis and developed a successful business with the frozen variety. Frozen cob corn packs in 1968 and 1969 were 76MM pounds, or more than twice as great as those in 1966 and 1967.

Pricing trends—Vegetable price increases are anticipated to be relatively modest, reflecting primarily increases in labor rates. They will be most severe in products requiring high labor inputs and could be influenced upwards by greater concentration of growers in cooperatives or other similar organizations.

Conclusions—From a food processor's viewpoint, we see the major growth trend in vegetables to continue to favor frozen vegetables. We see a particularly strong growth in the prepared vegetables as compared with regular vegetables.

Of lesser impact on the processor are the changes in use patterns of specific individual vegetables. Trends in package sizes or concepts are not expected to materially change the total vegetable business. And, finally, modest increases in vegetable prices are not expected to have a major impact.

PER CAPITA CONSUMPTION TRENDS

Fresh, frozen, canned:

	1948	*1958*	*1968*
Asparagus	2.13	2.07	1.46
Beans, lima	1.97	2.49	2.22
Beans, snap	6.56	6.60	6.73
Broccoli	1.13	1.14	1.44
Cabbage	18.08	13.14	11.85
Corn	22.27	24.64	27.39
Peas	13.23	12.03	13.38
Spinach	3.17	2.87	2.15
Tomatoes	46.49	54.24	62.61

Frozen:

	1948	*1958*	*1968*
Asparagus	.14	.15	.16
Snap beans	.29	.79	1.00
Lima beans	.38	.72	.74
Carrots	.05	.26	.72
Peas	.91	1.64	2.07
Broccoli	.17	.56	.78
Spinach	.31	.55	.70
Corn	.23	.69	1.58
Other	.10	.64	1.24

DISCUSSION

QUESTION: As we look to the future, do you foresee that vegetables are going to become a more or less important part of our diet? What kind of a role are vegetables going to play?

DR. SCHOEN: I think we would have to look at this in terms of total consumption and in terms of convenience foods. When we look at it from the frozen food industry viewpoint, we can see nothing but a continuation of the upward trend in convenience vegetables. But, in looking at the total consumption, here again I don't have figures available. We don't see it as a marked up turn in terms of per capita consumption. Probably with the availability of many other kinds of convenience foods, there could be in-roads into the vegetable area in the total consumption pattern. I suspect this is quite away down the road.

QUESTION: Do you think that the current trend of eating outside the home is going to have an impact upon per capita consumption? I am sure you are including restaurants—do you see a change here in the produce consumption pattern?

DR. SCHOEN: Well, not in the eating out. There are many specialty products when you start looking at that segment. I think there are very few special food outlets such as the burger franchises that have vegetable-based products. I don't know, but here could be a great opportunity. As far as the home, inside versus outside, I have no comments. Here would be an opportunity, from a market viewpoint, of making a special vegetable "thing" for franchise sale.

QUESTION: Do you think the industry will ever go to trying to sell nutritional qualities in frozen vegetables?

DR. SCHOEN: We have tried this in vegetables and other products and I guess it really boils down to not being able to sell nutrition today in the United States. If we had nutrition on top of quality to get a plus and not increase the cost measurably, yes, there is a place. We don't have particular examples in the vegetable area but in other products we have found in consumer tests that a nutritious version was not preferred over a nonnutritious version if the quality was lowered. Quality and nutrition must go together. Nutrition alone is not sufficient.

QUESTION: I was trying to see the decline in the boilable bag. Do you have any explanation of that? Are you doing any more work on it? Is it stabilizing, not declining?

DR. SCHOEN: No explanation as such, but the boilable bag is still an important part of the market.

QUESTION: What is the outlook for such crops as okra, southern peas?

DR. SCHOEN: Nationwide we would not see an uptrend in such individual vegetables as okra or squash. But in combination frozen vegetables, if the upward trend continues, there definitely could be growth opportunities for given individual vegetables.

QUESTION: From what sources or regions do you draw your materials primarily at this time?

DR. SCHOEN: Really, all over the country. It would depend. We have plants in the Northwest and in California and in the East.

QUESTION: Can you advise us of particular problems that we might have and might be looking for solutions in the southern areas?

DR. SCHOEN: There are no specific problems from our viewpoint other than the obvious. We see the vegetable market, in our corporation, as one in which there is considerable competition. Many of our competitors achieve quality. Our position is to maintain high quality and adding something to the product to make it superior. The convenience prepared vegetables are an example of this upgrading. Certainly we would continue to seek quality raw materials from the growers. In the combination vegetables, our requirements may become different than if we were packing off individual vegetables.

COMPETITION IN PEACH PROCESSING

by

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(Presented by W. Trotter)

The peach industry in the South historically has been geared to the fresh market. For many years the region has led the Nation in production of fresh peaches. Orchards are planted to varieties developed especially for the fresh market consumer. The processing market has assumed importance only during years of large supplies and depressed prices. There is reason to believe this situation may change. Increased costs of producing and marketing fresh peaches, changing consumer demand, and instability in the fresh market are factors contributing to increased interest in other market outlets. There is growing interest among all segments of the industry in developing an expanded processing market for peaches in the region.

In this paper today, we propose to do two things. First, we will review recent trends in peach production, utilization, and consumption. We must know where we are before we can consider where we are going. Secondly, we will examine some of the competitive factors important to establishing an expanded peach processing industry in the South. The major part of the paper will be devoted to these latter considerations.

RECENT TRENDS

Production trends.—With the exception of 1967, peach production nationally since 1960 has been relatively stable, varying between 3.1 and 3.5 billion pounds (table 1). The year 1967 was a bad crop year in all producing areas and total production that year amounted to only 2.5 billion pounds. Total production during the 1960-1968 period averaged 3.2 billion pounds.

For the United States as a whole, the processing market has taken the major share of the crop since 1960, averaging over 58 percent. This portion increased from about 50 percent in 1960 to just over 60 percent in 1968.

To examine peach production and utilization trends on a regional basis, we have divided the

Table 1.—*U.S. production of peaches for fresh market and processing, 1960-68*

Year	Total U.S. production	Fresh market	Processing market	Percent for processing[1]
	Bil. lb.	*Bil. lb.*	*Bil. lb.*	
1960	3.4	1.7	1.7	50.8
1961	3.5	1.7	1.8	51.6
1962	3.3	1.5	1.9	55.7
1963	3.4	1.4	2.0	58.4
1964	3.2	1.2	2.0	62.4
1965	3.1	1.3	1.8	58.1
1966	3.2	1.2	2.0	62.2
1967	2.5	0.9	1.6	62.5
1968	3.4	1.3	2.1	60.8
Average	3.2	1.4	1.9	58.1

[1] Computed before rounding.

Source: The Almanac of the Canning, Freezing, Preserving Industries—1969 (Maryland: Edward E. Judge & Sons, 1969).

Table 2.–*Peaches for fresh market: Percent of U.S. production by region, 1960-68*

Year	South	West	North Atlantic	North Central
	Percent	*Percent*	*Percent*	*Percent*
1960	47	21	17	15
1961	50	22	13	15
1962	47	26	17	10
1963	57	21	15	7
1964	29	29	22	20
1965	50	22	17	11
1966	56	23	13	8
1967	56	22	10	12
1968	59	17	17	7
Average	50	23	16	12

Source: The Almanac of the Canning, Freezing, Preserving Industries–1969 (Maryland: Edward E. Judge & Sons, 1969).

United States into four regions. The Southern region consists of the 16 South Atlantic and South Central States. The North Atlantic region consists of the New England and Middle Atlantic States. The North Central region is made up of the East North Central and West North Central States. The Western region consists of the Mountain and Pacific Coast States.

In each region one or two States account for the major share of peach production. In the Southern region, South Carolina and Georgia; in the North Atlantic States, Pennsylvania and New Jersey; in the North Central States, Michigan; and in the Western region, California.

The South is the leading region in production of fresh market peaches accounting for an average of 50 percent during the 1960-68 period (table 2). This percentage varied from a low of 29 percent in 1964 (a bad crop year in the South) to 59 percent in 1968. The Western and North Atlantic regions accounted for an average of 23 percent and 16 percent, respectively, of the fresh market total. The North Central region, primarily Michigan, accounted for an average of 12 percent of the fresh market supply in recent years.

Table 3.–*Peaches for processing: Percent of U.S. production by region, 1960-68*

Year	South	West	North Atlantic and North Central
	Percent	*Percent*	*Percent*
1960	6	91	3
1961	5	92	3
1962	4	94	2
1963	6	93	1
1964	1	98	1
1965	7	92	1
1966	4	95	1
1967	[1]	98	2
1968	7	92	1
Average	4	94	2

[1] Less than one-half of 1 percent.

Source: The Almanac of the Canning, Freezing, Preserving Industries–1969 (Maryland: Edward E. Judge & Sons, 1969).

With respect to peaches for processing, the West is by far the leading region, producing an average of 94 percent of the total during the 1960-68 period (table 3). The South is next in importance but produces a rather small share of the total. This share varied from less than one-half of 1 percent to 7 percent and averaged 4 percent during the 1960-68 period.

Utilization trends.–As shown in table 1, the utilization of peaches for processing has increased in recent years. Although processing was once looked upon only as a salvation for the fresh business in years of trouble, this is no longer true. From 1960 through 1968, the average distribution of peach sales was as follows: 53.0 percent canned, 41.7 percent fresh, and 5.3 percent dried, frozen, or other processed forms. Today, then, the processed market (which includes canned, frozen, and dried peaches) substantially exceeds the fresh market.

Utilization of peaches differs greatly among the different production regions. For instance, table 4 shows that 85 percent of the peach crop in the west has been used for processing in recent years while the fresh market used only 15 percent. In the southern states, nearly 88 percent of the peach crop was used in the fresh market during the 1960-68 period. With the exception of bad crop years in 1964 and 1967, peaches for processing have shown a moderate increase in importance in the South, accounting for 17 percent of the total in 1968.

In the North Atlantic region, fresh market sales on the average accounted for over 93 percent of the total. Utilization of peaches for processing decreased in this area since 1960 to average about 7 percent of sales for the period. Utilization in the North Central States is similar to that in the North Atlantic in that fresh sales make up an increasingly larger share of sales while processed sales have declined in importance.

Consumption trends.—Per capita peach consumption follows closely peach production. Bad crop years in 1950, 1955, 1964, and 1967, which led to sharp declines in production, are reflected by a fall in per capita consumption during the same years. During the years of low production, consumption of fresh peaches was affected more than canned, dried or frozen peaches.

There has been a gradual shift in demand for fruits and vegetables from fresh to processed forms. Since 1950, consumption of fresh fruit has declined by a greater amount than canned

Table 4.—*Utilization of peach production by region, 1960-68*

Year	South		West	
	Fresh	Processed	Fresh	Processed
	Percent	*Percent*	*Percent*	*Percent*
1960	87.9	12.1	18.7	81.3
1961	89.3	10.7	18.8	81.2
1962	88.2	11.8	18.3	81.7
1963	85.8	14.2	14.0	86.0
1964	92.4	7.6	14.8	85.2
1965	82.5	17.5	14.9	85.1
1966	86.5	13.5	13.0	87.0
1967	93.3	6.3	12.1	87.9
1968	82.8	17.2	10.8	89.2
Average	87.6	12.3	15.0	85.0

	North Atlantic		North Central	
	Fresh	Processed	Fresh	Processed
	Percent	*Percent*	*Percent*	*Percent*
1960	91.2	8.8	85.7	14.3
1961	92.1	7.9	86.0	14.0
1962	94.0	6.0	84.9	15.1
1963	93.4	6.6	83.4	16.6
1964	92.3	7.7	89.3	10.7
1965	92.5	7.5	86.2	13.8
1966	94.1	5.9	88.7	11.3
1967	96.3	3.7	88.4	11.6
1968	94.6	5.4	94.0	6.0
Average	93.4	6.6	87.4	12.6

Source: The Almanac of the Canning, Freezing, Preserving Industries—1969 (Maryland: Edward E. Judge & Sons, 1969).

and frozen fruit have expanded—so that in total, per capita fruit consumption has declined. The decline in consumption is accounted for by the fresh and dried components.

These consumption trends usually vary from one commodity to another. However, trends in peach consumption compare quite closely with fruit consumption in general. Data in table 5 indicate a declining trend in total per capita consumption. This decline results from decreases in the quantity consumed of dried and fresh peaches. On the other hand, per capita consumption of canned peaches is rising because of increasing utilization of canned peach halves and peach slices as well as peaches mixed in fruit cocktail. Future demand for canned peaches looks favorable because of growth in population coupled with an increasing trend in per capita consumption.

IMPORTANT COMPETITIVE FACTORS

To most effectively contribute to the future economic growth and prosperity of the South, it would seem that increased emphasis should be given to the expansion of the processing sector of the peach industry. Successful expansion of this sector depends on the region's competitive position relative to other peach producing regions. Some of the more important factors that affect the region's competitive position are: (1) yield per acre compared with other regions; (2) costs of producing peaches for processing relative to costs in other regions; (3) costs of processing; (4) transportation costs to major consuming areas compared with costs from other producing regions; and (5) quality of the finished product.

Yields.—Average yields of peaches per acre in

Table 5.—*Peaches: Per capita consumption, 1950-68*

	Pounds per capita, fresh equivalent basis					
		Canned				
Year	Fresh	Halves and slices	Mixed in fruit cocktail	Frozen	Dried	Total
1950	6.9	5.1	0.8	0.20	0.76	13.8
1951	8.4	4.2	0.6	0.20	0.83	14.2
1952	9.5	4.4	0.8	0.25	0.69	15.6
1953	9.2	4.6	0.7	0.28	0.69	15.5
1954	9.0	4.9	0.8	0.21	0.69	15.6
1955	5.5	4.8	0.8	0.33	0.62	12.1
1956	8.2	4.6	0.8	0.29	0.49	14.4
1957	7.9	5.0	0.8	0.30	0.49	14.5
1958	9.7	5.0	0.8	0.18	0.42	15.8
1959	9.0	5.1	0.9	0.28	0.49	15.8
1960	8.7	5.3	0.9	0.30	0.42	15.6
1961	8.9	5.4	0.9	0.34	0.35	15.9
1962	7.6	5.5	1.0	0.38	0.49	15.0
1963	7.1	5.7	0.8	0.40	0.35	14.4
1964	5.6	5.7	1.0	0.30	0.28	12.9
1965	6.5	5.7	0.8	0.40	0.35	13.8
1966	5.9	5.4	1.0	0.38	0.28	13.0
1967	4.5	5.2	0.9	0.38	0.21	11.2
1968	6.3	5.4	1.0	0.36	0.21	13.3

Sources: Economic Research Service. Food: Consumption, prices, Expenditures. U.S. Dept. Agr., Agr. Econ. Rpt. No. 138. 1968.

Economic Research Service. Fruit situation. Washington, U.S. Dept. of Agriculture, 1969.

Sidney Hoos and George M. Kuznets, Pacific Coast canned fruits f.o.b. price relationships, 1968-69. Giannini Foundation Research Report No. 302. Berkeley, Calif. Agr. Expt. Sta., 1969.

major producing States for 1967 and 1968 are shown in table 6. Yields in 1967 were low for all states. The 1968 data appear more representative with the exception of yields in Michigan. Yields in Michigan were low both years. Yields in California averaged nearly twice those for South Carolina and Georgia, the principal producing States in the South.

Table 6.—*Average per acre yields of peaches in major producing States, 1967 and 1968*

State	Yield per acre	
	1967	1968
	Tons	*Tons*
California	9.4	11.7
Clingstone	9.8	12.2
Freestone	8.2	10.5
South Carolina	2.5	6.9
Georgia	2.8	5.5
New Jersey	2.5	4.4
Pennsylvania	2.2	5.2
Michigan	2.6	1.3

Sources: W. Ward Henderaon and James M. Kitterman. California fruit and nut statistics, 1967-68. Sacramento, Calif. Crop and Livestock Rpt. Serv., 1969.

Estimates furnished by Clyas L. Crenshaw, Agricultural Statistician, Georgia Crop Rpt. Serv., Athens, Ga., Dept. Agr.

Donald W. Barrowman, New Jersey orchard and vineyard survey, 1967. Trenton, N. J. Crop Rpt. Serv., Circ. 443, 1968.

B. Dale Hall, Michigan agricultural statistics. Lansing, Mich. Dept. Agr., 1969.

Table 7.—*Estimated costs of producing peaches for processing in major producing States, 1968*

State	Yield per acre	Cost per ton
	Tons	*Dollars*
California	15.0	69.69
Georgia	3.8	64.29
Michigan	4.8	116.14
New Jersey	5.9	116.80
North Carolina	7.2	63.50
Pennsylvania	3.7	106.75
South Carolina	5.7	72.17

[1] Data for California are based on clingstone peaches; data for other States are for freestone peaches.

Production costs.—Estimated costs of producing peaches for processing are shown in table 7. These estimates were developed from surveys of peach producers made by Departments of Agricultural Economics or Extension Services in the respective States. We have revised the estimates where needed to make them comparable in terms of cost items covered. In each case orchard establishment costs, prorated over the productive life of the tree, are included. All estimates were converted to a 1968 basis through use of the index of farm production cost. Because of lack of comparability in the basic data, the estimates should be considered as "ball park" figures. We believe, however, they are sufficiently accurate to be meaningful in the context in which we are using them.

The variance in yield among region appears to have little influence on relative costs of producing peaches. Costs per ton in California with 15 ton yields are of the same magnitude as cost in the Southeast with 4 to 7 ton yields. Major offsetting factors are land costs and labor rates. Costs in Michigan and Pennsylvania are high because of higher land charges, labor rates, and other costs in those areas without offsetting yield increases.

Processing costs.- Preliminary estimates of processing costs for canned peaches are given in table 8 for California and the Southeast. Raw product costs are excluded. The California data are based on a 1964 study by the Canners League of California. The 1964 data were converted to a 1968 base by use of the wholesale price index for processed fruits and vegetables. The Southeastern data were derived from studies made by Clemson and North Carolina State Universities with revisions based

Table 8.—*Preliminary estimates of canned peach processing cost, 1968.*

Producing area	Cost per case[1] 24 No. 2-1/2
	Dollars
California	3.92
Southeast	4.03

[1] Cost per case excluding raw product costs.

Table 9.–*Comparison of freight rates on canned peaches between selected origin and destination points, 1969.*

Destinations	Origins[1] Stockton, Calif.	Spartanburg, S. C.	Differential (Stockton-Spartanburg)
	Cents/cwt.	*Cents/cwt.*	*Cents/cwt.*
Boston	183	89	+ 94
New York	183	75	+108
Detroit	172	77	+ 95
Chicago	164	73	+ 91
Minneapolis	164	96	+ 68
Omaha	153	96	+ 57
Atlanta	183	27	+156
Dallas	153	89	+ 64
Los Angeles	32	183	–151
Portland	59	183	–124

[1] All rates are lowest rail rates regardless of carlot minimum weight.

Source: Estimates furnished by Jack W. Boehl, Chief of the Traffic Management Branch. U.S. Dept. Agr., Agr. Stabil. Conserv. Serv., Washington.

on suggestions of processors in the region.

The lower costs in California probably result from economies achieved through the larger scale of operation in this state as compared with the Southeast.

Freight rates.–Rail freight rates on canned peaces from Stockton, Calif., and Spartanburg, S. C., to 10 major consuming centers are shown in table 9. These are the lowest rates between the indicated points regardless of carlot minimum weights.

The Spartanburg origin has a rate advantage over a major part of the most densely populated parts of the United States. This advantage among the destinations shown ranges from 64c per cwt. in Dallas to 156c per cwt. in Atlanta.

Total delivered costs.–A comparison of costs per case of canned peaches delivered to selected destinations is shown in table 10. These are estimated costs delivered to the indicated

Table 10.–*Costs of canned peaches delivered to selected destinations*[1]

Destinations	Origins Stockton, Calif.	Spartanburg, S. C.	Differential	
	Dollars per case	*Dollars per case*	*Cents per case*	*Cents per can*
Boston	6.50	6.09	+41	+1.7
New York	6.50	6.02	+48	+2.0
Detroit	6.44	6.03	+41	+1.7
Chicago	6.40	6.01	+39	+1.6
Minneapolis	6.40	6.13	+27	+1.1
Omaha	6.34	6.13	+21	+0.8
Atlanta	6.50	5.76	+74	+3.0
Dallas	6.34	6.09	+25	+1.0
Los Angeles	5.70	6.59	–89	–3.7
Portland	5.84	6.59	–75	–3.1

[1] Costs of producing, processing, and transporting per case of 24 No. 2-1/2 cans. California data are for clingstone peaches; South Carolina data are for freestone peaches.

destinations rather than selling prices. The estimates include costs of producing peaches for processing, estimated processing costs, and transportation. No allowances have been made for retail and wholesale distribution costs in consuming markets or for profits above a normal return on investment.

Again, the advantage of the Spartanburg origin over the Stockton origin is indicated for eight of the 10 destinations shown. This advantage covers areas containing roughly 80 percent of the total U.S. population. The advantage ranges from 0.8 cent per can in Omaha to 3.0 cents in Atlanta.

Other considerations.—With these apparent economic advantages, why has the Southeast remained relatively small as a peach processing region? Some considerations we believe important are these:

1. The Southeast has concentrated on the fresh market and the industry is oriented in that direction. There is growing interest, however, in producing peaches for processing and some commercial plantings of varieties having improved processing characteristics are now being made.

2. There is a lack of continuity in the supply of peaches available for processing. This lack of continuity stems principally from two things: (1) The fresh market gets first choice on the available supply; and (2) weather conditions, such as heavy rains or drought during the growing season or severe freezes after bloom, may adversely affect the crop at too frequent intervals. Peaches in California, on the other hand, are grown under essentially controlled conditions.

3. Competitive factor is product quality. It is generally recognized there is a distinct difference in appearance and texture between canned Southeastern freestone and California cling peaches. Presumably because of this quality difference, to get volume movement into a market, Southeastern peaches generally must be priced to sell somewhat below Western clings. This price difference is probably sufficient to offset any economic advantage the region might enjoy.

Another competitive advantage of the large western canners is the massive promotion and merchandising methods they are able to employ. They can guarantee a continuous supply of the uniformly high quality product required by today's large food chains.

MARKETING OF COTTONSEED PRODUCTS

by

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Before we look at the cottonseed products, we need to look at the "dog" that wags the tail. That is, cotton itself. The farmer, first of all, grows his crop for the cotton. For every bale of cotton, approximately 800 pounds of cottonseed is produced, thus total cottonseed products and prices under the support level is affected by the cotton program.

Whether we are for the set-aside approach or for "production goal acreage," whether we are in favor of "supply management" or opposed to it, whether we want more or less government in the business of producing and selling nature's miracle fiber, it is an unalterable fact that the history of cotton since our country emerged from the Great Depression has been very much the history of a succession of government programs.

Whether all of these programs—or which of them—were wisely conceived and well administered might be debated extensively, but one thing which all of these programs have had in common is to *contain* or *control* production. Except for brief periods during and after World

War II and the Korean War, when carryover dropped below 3 million bales, there always seems to have been too much cotton. In all but 10 of the last 37 years there have been acreage controls on cotton, and the 10 years without restrictions were during and following the two wars. The first "Agricultural Adjustment Act" was passed in May of 1933. Much of our current program is based on the "Agricultural Adjustment Act of 1938" and the Nixon Administration's "Concensus Bill" to a large extent is a further amendment of that 1938 Act.

A few "numbers" are necessary to bring the history of the last 37 years into focus. We have already mentioned the carryover; it reached its low in 1951 with 2,278,000 bales and its high in 1966 with 16,862,000 bales, and averaged 8,826,000 bales. It is predicted at about 5,900,000 bales on July 31, 1970.

Production ranged from a high of 18,946,000 bales in 1937 to a low of 7,458,000 bales 30 years later in 1967, with an average for the 37 years of 12,737,000 bales. But the average for the past 4 years, from 1966-69, was only 9,515,000 bales.

U.S. mill consumption ranged from a low of 5,361,000 bales in 1934 to a high of 11,170,000 bales in 1941, averaging 8,657,000 bales, and presently seems to be holding steady at slightly above 8 million bales.

Exports since 1933 averaged 4,705,000 bales, after eliminating the years from 1940 through 1947 for World War II and its aftermath. It is perhaps a long forgotten fact that at the beginning of the period we are talking about (1933) exports at 7,534,000 bales exceeded U.S. mill consumption at 5,700,000 bales. For the present season, there is some doubt that exports will reach 2-1/2 million bales.

The Commodity Credit Corporation (CCC) was chartered in 1933 and soon became the largest cotton merchant of all time, beginning almost every season with a multi-million bale inventory that reached its peak in 1966 with more than 12 million bales. This had the natural consequence that CCC sales policy announcements became a dominant market factory.

In these 37 years the statistics abroad have been more exciting than in the United States. Total foreign production increased from about 15 million bales in 1933 to about 42 million bales in 1969. The Communist countries more than tripled their production from less than 5 million to more than 15 million bales, but the foreign free world also did good by increasing its production from about 10.1 million bales to about 26.6 million bales.

But by far the greater market loss of U.S. cotton—or failure of the market to grow—comes from manmade fibers. Cotton is no longer king of the fiber world. In the United States, cotton's share of the fiber market slipped below 50 percent sometime between 1967 and 1968. At present the fiber market is no more than 40 percent. In 1933, cotton held 85 percent of the domestic market.

This history of cotton may appear too long and drawn out, but I could not realistically talk about marketing of the products without showing what is happening and has happened to cotton.

Cottonseed also has been under the support program, of some nature, since 1942 except years 1946-48. Various programs of supporting products have been used. Since 1960, only 3 years—1961, 1963, and 1968, did CCC have to purchase oil or oil and meal under their program.

The 1969 crop cottonseed price support to farmers was $37 per ton (basis 100 grade). This is $11 per ton lower than last year. (At the same time soybean support price was decreased from $2.50 per bushel to $2.25 per bushel.) By law, cottonseed and soybeans must be supported at levels that will enable them to compete on equal terms in the market. CCC then agrees to purchase oil from the crushers, who agree to pay not less than equivalent support price of $41 per ton at the gin. This gives the gin $4 per ton as their ginning fee. To date, this season, no tenders have been made by any crusher. With the current high prices of both oil and meal, we do not anticipate any for the balance of the season.

Last year was a different story. CCC purchased 331 million pounds of cottonseed oil and 143,000 tons of cottonseed meal. As we approached the 1969 crop, these large suppliers of products, in the hands of CCC, had the effect of huge dark clouds hovering over the new crop market. Prices did start the year on a lower basis but increased beyond our wildest expectations.

Cottonseed meal prices this year have experienced the widest fluctuations we have witnessed in years. In retrospect, several situations and conditions have contributed to the causes.

First of all, CCC had 143,000 tons of meal in storage August 1, 1969 from the 1968-69 crop. Most of this meal was sold for domestic use and will be off of CCC's books by the end of this month.

Combined with the consumption of this large tonnage, the mills through most of February shipped the meal as produced and in some cases had to ration shipments. We can say that from one year to another we have gone from "feast to famine."

The unusually cold weather increased the need for additional feed. High protein consuming animals may total 165 million units, 5 million more than in 1968-69. These increased units are expected to lift high protein feeding over the 19 million ton mark for the first time. The total now forecast at 19.3 million tons would be 800,000 tons above 1968-69. Granted, soybean meal will make up a large percentage of this increase, but prices for all proteins have benefited.

A sharp reduction in world fish meal supplies, coming at a time of strong feed demand, has been accompanied by high meal prices. Prices quoted last week were $200 Westcoast, which is $75 higher than a year ago. The supplies are increasing, therefore, prices will be more competitive.

The past few months have shown good feeding ratios. When this happens, the feeder will pay higher prices rather than change formulas, or substitute synthetics.

A large portion of meal produced east of Arizona is fed primarily to range cattle and fat cattle in feed yards. There has been a strong demand for pellets and high protein range blocks. With spring-like weather now prevailing over the territory, this type feeding is about through for this season. We have seen prices from a low of $57 to a high of $90 per ton. The current price is from $65 to $75. This depending on the type of meal and location.

Many of the mills will be completing their crush in the near future. The short cotton crop does not produce enough cottonseed to supply yearround volume for mills. For this reason, the supply of meal will come into balance with the price. We foresee higher meal prices in the late summer.

In Arizona and California, a degossypolized meal is produced. The inherent nature of seed makes this possible. We estimate over 70 percent of the solvent meal produced in this area is sold to the poultry feed manufacturers. This type meal is used up to 7-1/2 to 10 percent in the total ration and replaces soybean meal.

Large quantities of this meal was sold at the beginning of the season for $54 to $55 per ton. Now the supply is limited, and the price is $78 to $80. We do not foresee any marketing problems for selling the balance of this year's crop.

If you ask me today to explain the wide price fluctuation and the additional demand, I could not give an answer in totality. Some observations are apparent:

1. When the price reaches $54 to $58 range, then cottonseed meal will start replacing urea in cattle and dairy rations.
2. With good feeding ratios, the feeder will pay higher prices for quality ingredients.
3. The population increase has necessitated more high protein consuming animals. This trend should increase for the next few years.
4. Combined domestic disappearance of soybean meal and cottonseed meal during September to January was about 550,000 tons (9.4 percent) greater than the same period last year.

As stated above—these are observations, but we hope these are helpful in answering your questions pertaining to marketing of cottonseed meal.

The cottonseed oil outlook held many of the same aspects as the meal. Before this season we had an excellent outlook for a substantial cotton crop, the Commodity Credit Corporation held a significant quantity of last year's cottonseed oil production, and the soybean crop looked to be the largest on record. This was clearly not a situation conducive to a major bull move in the cottonseed oil market.

As the harvest season approached, the crop deteriorated, CCC sales to restricted destinations were moving well, Russian sunoil offerings were conspicuously absent, and talk of marketing problems in Nigeria sent ground-nut oil prices soaring. To say the least, the situation was rapidly changing.

Exports of cottonseed oil began to take hold and have led the way this year. Exports for the October/January period this year were over 200 million pounds compared with less than 33 million in the same period last year. I'm not even sure they counted all those trucks crossing the Mexican border.

This significant increase in exports, coupled with a domestic disappearance exceeding last year's rate, have nearly depleted the CCC-owned stocks of refined cottonseed oil, with the exception of the lower quality oil still in storage.

This change in the international fats and oils situation has resulted in a price swing of approximately 4c per pound for crude cottonseed oil since the beginning of this season.

A look at the future cottonseed oil market would not be complete without consideration of the major vegetable oil produced in the U.S.—soybean oil. I'm sure you're all well aware of the fact that as cottonseed oil availabilities have dwindled in recent years, soybean oil has raced to the forefront. Improvements in refining processes of soybean oil, and its cheaper price, have all but eliminated any domestic use of cottonseed oil, except the hard-core demand where substitution is not possible, which has leveled off for the past several years at approximately 1 billion pounds.

Consumption of soybean oil has been racing at a pace exceeding even the most optimistic expectations. On the export side, the ultimate volume of PL-480 shipments appears to be more a function of budgetary policy than demand factors. For the balance of this crop year, with current oil inventories at manageable levels, the price outlook is good. Despite a record soybean crush, the spot oil position has remained tight with prices at a premium to the deferred delivery months.

In relation to the soybean oil situation, the cottonseed oil availabilities will contract at a rapid pace as mills complete their crush. This could lead to price action independent of soybean oil as the need to compete pricewise is reduced.

Looking farther into the future on cottonseed oil is a considerably more difficult task owing to many unknown factors. Of primary importance is the impact of a new farm program on the quantity and distribution of cotton to be planted. The selected combination of support price level, allotments, payment limitations, and acreage controls can result in a greatly differing planting distribution.

The demand side of the coin is almost equally as cloudy. There are many situations in the world market that will vary from year to year depending on crop conditions. One of the major influences in recent years—Russia—has reportedly embarked on a program of increasing domestic consumption of fats and oils, which could well remove her as a primary factor in the European oil market.

In summary, cottonseed oil possesses a healthy hard-core market demand. The past has shown that with adequate supplies and a competitive price, cottonseed oil can compete with any oil around. Its competitive position could be improved by the removal of the proverbial "government umbrella," which covers the cotton program. At this point, however, what the future holds, only time will tell.

Cottonseed hull is the outer hull of the seed after the lint has been removed. These are light in weight, high in fiber, and because of its nature are usually sold in the local markets.

The primary market is a roughage feed for cattle and dairy. A small percentage is sold to the oil field drilling industry for mud preparation.

This year the price started out in orderly manner at $10 per ton in the Mississippi Valley and Arkansas. However, a demand arose on the Plains of West Texas to supply the large influx of cattle into new feeding operations. Hulls were shipped westward from the Mississippi Valley and eastward from as far as California. The prices increased to a high of $27 per ton in the Mississippi Valley and $29 per ton in Arkansas. Currently, the prices are about $14 per ton. At one time, hulls were delivered in the Lubbock, Tex. area at $40.

No doubt, the high price has resulted in some loss of business. Feed lot operators tell us they can go to a high energy ration and eliminate roughage. We hope now the hull price is in the moderate range so that hulls will continue to be used in feed lot rations.

The "Cattle on Feed" report shows that on February 1, cattle on feed are up 8 percent from a year earlier in six States—Arizona, California, Colorado, Iowa, Nebraska, and Texas. Cattle on feed in these States totaled 7.3 million head. Texas continued to show the largest increase from a year earlier—up over 30 percent. The demand is available, I hope we can supply the need.

We can predict another shortage in the late summer and early fall. The same old reason is, because of the short cotton crop, there is not enough cottonseed available for the mills to crush on a yearround basis. Unfortunately, the cattle on feed cannot understand that most oil mills only operate 6 to 8 months. Many mills have a limited storage for hulls, so this creates a void.

It would not be appropriate to talk about cottonseed products without including at least a few remarks about our number one production per sales headache—linters.

This has been one of those rare years when linters' prices have remained fairly stable throughout the entire season. As you all know this is the exception rather than the rule for this commodity as over the years linters have been on an almost constant roller coaster ride up one season and down the next.

At present, the linter situation seems to parallel the cotton outlook to the extent that, even though production has fallen far below early season expectations, the market response has been negligible. This was to be the year when we won back some of our markets with lower prices. Even though the lower prices are still with us, however, we have seen little in the way of increased consumption. At this point, it appears that a small rise in bleacher consumption will be more than offset by reduced usage by other linters' consumers.

The main ingredients of our present dilemma would seem to be (1) Lack of adequate supplies present or future to keep pace with increased demand generated by our economic and population growth; (2) competition from other materials either cheaper in initial cost or cheaper in the finished product due to reduced labor and equipment requirements in utilizing these other materials; (3) foreign competition for our traditional export markets fostered by our cotton program in recent years which has encouraged a substantial increase in non-U.S. linter production under the high prices and short supplies created in the first 2 years of the current program. As an example of this, we repeat a statement made by one of our foreign agents about 2 years ago. I quote: "The linters shortage in the U.S. is more than compensated by new linters production in countries trying hard to increase their exports. The present U.S. shortage is a God-sent for these countries who are filling the vacuum created by U.S. policies." I think this statement pretty well spells out the current ills of cotton linters. Ten years ago exports of linters averaged about 325,000 every season, whereas our exports for the past three seasons have averaged only about 175,000 bales.

I would like to be more optimistic about the future, however, we can see nothing in the picture over the next few years to change current trends. The picture is darkest for first-cut linters as there continues to be a trend away from this material by the major users, namely, automobiles, furniture, and bedding. Automotive looks particularly dark, as it is reported that these consumers intend to phase out the use of cotton linters in car seats over the next 2 to 3 years in favor of molded polyurethane and foam rubber which lends itself more easily to the current trends in automotive padding and seating. There is also a Federal proposal in the works to require that all padding material for consumer use be made fire retardant. Unless some inexpensive method is found to accomplish this, this law could well be the death knell for many smaller consumers who could not afford or justify the required equipment since it is doubtful that any of the cost could be passed on considering the competitive situation.

The second cut situation is not nearly so bleak as first cuts for various reasons. The very thing that is hurting cotton, *synthetics*, is creating a larger market for chemical linters in the specialty paper field formerly supplied to a large extent by cotton rags. With the present trend to synthetics or synthetic-cotton blends in fabrics, it is fast becoming impossible for these users to find pure cotton rags. We expect this trend to continue. Wood pulp, an implacable foe of chemical linters since World War II is reportedly operating at full capacity and unable to supply additional demand at present. In view of this situation, it seems likely that there will be price increases by these producers, and less effort on their part to capture markets presently supplied by linters. On the other side of the coin, we are gradually losing the substantial ordnance demand created by the Vietnam War. At present, this is of no real concern as the combination of lower prices/wood pulp shortage/crop shortage have tended to maintain chemical linters consumption at the highest level achieved in recent years.

There seems to be little room for optimism about exports since our foreign competitors will take the bulk of this business at whatever price necessary. Foreign consumption is apparently up over the recent years, but this has not resulted in any appreciable increase in demand for U.S. linters.

When thinking about the future for linters, particularly in bad times, we always tend to fall back on the old cliche that regardless of price, linters will find a market. Since the production of linters is only an incidental, but necessary evil, in the proper processing of seed for its primary products—oil and meal—it has always been thought that at some price this material will be utilized. This axiom may still be valid, but not nearly to the extent of a few years ago. There are just too many substitutes available at stable prices and in more or less unlimited supply for us to take solace in this kind of thinking today. What we need are new markets and at present there seems to be few worlds left to conquer for this byproduct.

In summary, we need to know that we can offer quality products at comparable prices. All the cottonseed products have established their known values. The glandless cottonseed would definitely give an improved oil and meal value, but here again, the lint and not the seed is the governing factor.

We think the price support level of cottonseed now is low enough that the products can seek their level. We hope acreage control on cotton can be amended so more cottonseed is available for crushing. This would give cottonseed products a chance of securing a larger portion of the domestic and world market.

COMPETITION FOR THE PROTEIN MARKET

by

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Dr. Efferson made it very clear that the "Green Revolution" in developing countries is not progressing very well. Dr. Senti's figures on nutrient deficiencies in the United States, although not illustrating an immediate need for protein, suggest a possible trend in increased nutritive needs. To be sure, the cotton people would not be working on protein products if there were not a potential market. These gentlemen have made the subject of my talk rather timely, because I feel that every day in most parts of the world people are suffering from the effects of inadequate diets. We've seen the pictures in the newspapers, heard the figures from national and world leaders, and yet, it all really seems so far away.

I, personally, am not worried about the nutritive value of my next meal—I never have been—and probably neither have most of you. But, if we, the agriculturally informed and aware people in our society, are not worried about it, to what extent do you think the uninformed and unaware individual worries about it? Certainly, the average individual is concerned about *quantity* and in many cases he can get all he wants of fairly low protein foods. So I don't think there is any argument about whether there is a need for protein in the world; or for that matter, in our own country.

This need—present and future—is basically a result of an imbalance caused by man:

- through the overpopulation of his living areas, and
- through his poor planning in the agricultural and industrial sectors.

We should not want in the future because of poor planning today. So, on this note, I would like to try to approach the subject of this talk by briefly describing:

- where the need lies,
- what competition for the present market should exhibit as nutritional, functional, and economic properties,
- and try to cover some of the highlights about proteins derived from single cells.

As we are all well aware, the population of our country is expected to soar to 300 million by the year 2,000. Meanwhile the most alarming view of the world population's growth is expressed in figure 1.

Taking a broad but realistic view of history, we can easily see the *frightening* growth curve and its *sharp upward movement* corresponding with public health and industrial advances. One hesitates to look beyond the year 2,000 in view of the virtual 90° direction of this curve. The major share of this huge increase is expected to be taken up by parts of the world which can least afford it.

To put it into another context, figure 2 illustrates the relationship of the world's population growth to the quantity of land available for agricultural exploitation. Based on the known trend in increasing arable land in the world, the land available today plus 5 percent will have to feed twice the present population by the year 2,000. No doubt, during this period tremendous technical strides will take place in plant breeding, husbandry, food preservation and other agricultural sciences; but can these advances be implemented in time and will they suffice? Many people believe these figures, and so work continues on around the world in an urgent effort to stem the tide of hunger suggested by these projections.

In addition to the overall picture those relatively affluent societies, such as our own, will turn more and more to convenience foods. Our changing life style de-emphasizes large well-balanced meals, while between-meal snacks and prepared foods are extremely popular. This trend, and paradoxically a simultaneous interest in nutrition by the citizenry, will no doubt induce increased demands for high protein products.

Now that I've very briefly suggested where the need for protein lies and the nature of it, I would like to touch on some of the requirements of protein ingredients. The most important aspects of protein ingredients are:

(a) Nutritive value.

(b) Functional properties.

(c) Potential supply.

(d) Growth and manufacturing requirements.

(e) Price.

In this regard, each major protein ingredient excels on one score or another. Caseinate exhibits excellent nutritional properties while its functionality is rather limited because of several reasons. Meanwhile, although soy proteins lack methionine and exhibit a Protein Efficiency Ratio lower than casein, various products have

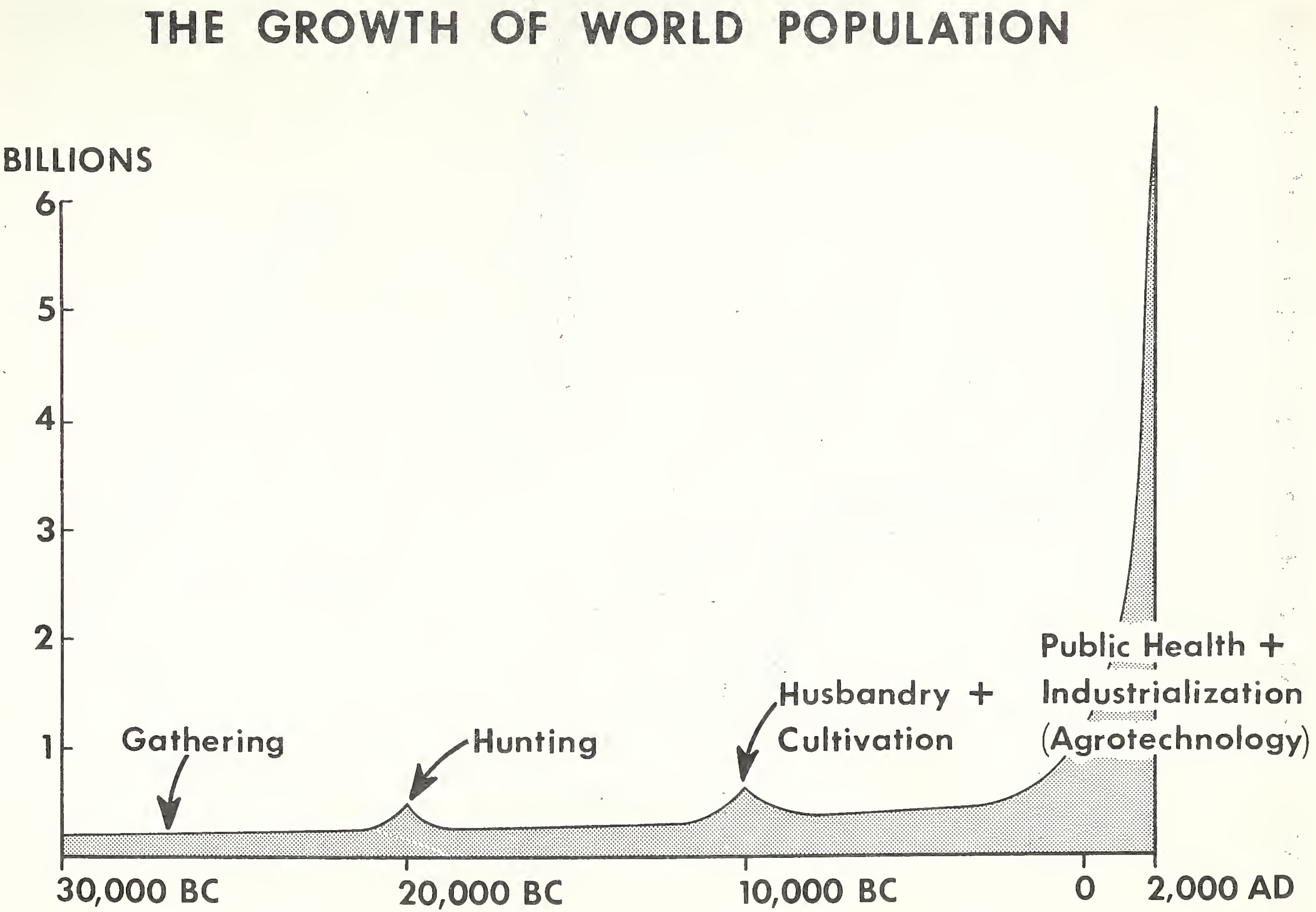

Figure 1.—THE GROWTH OF WORLD POPULATION.

ARABLE LAND, A RELATIVELY INELASTIC FACTOR

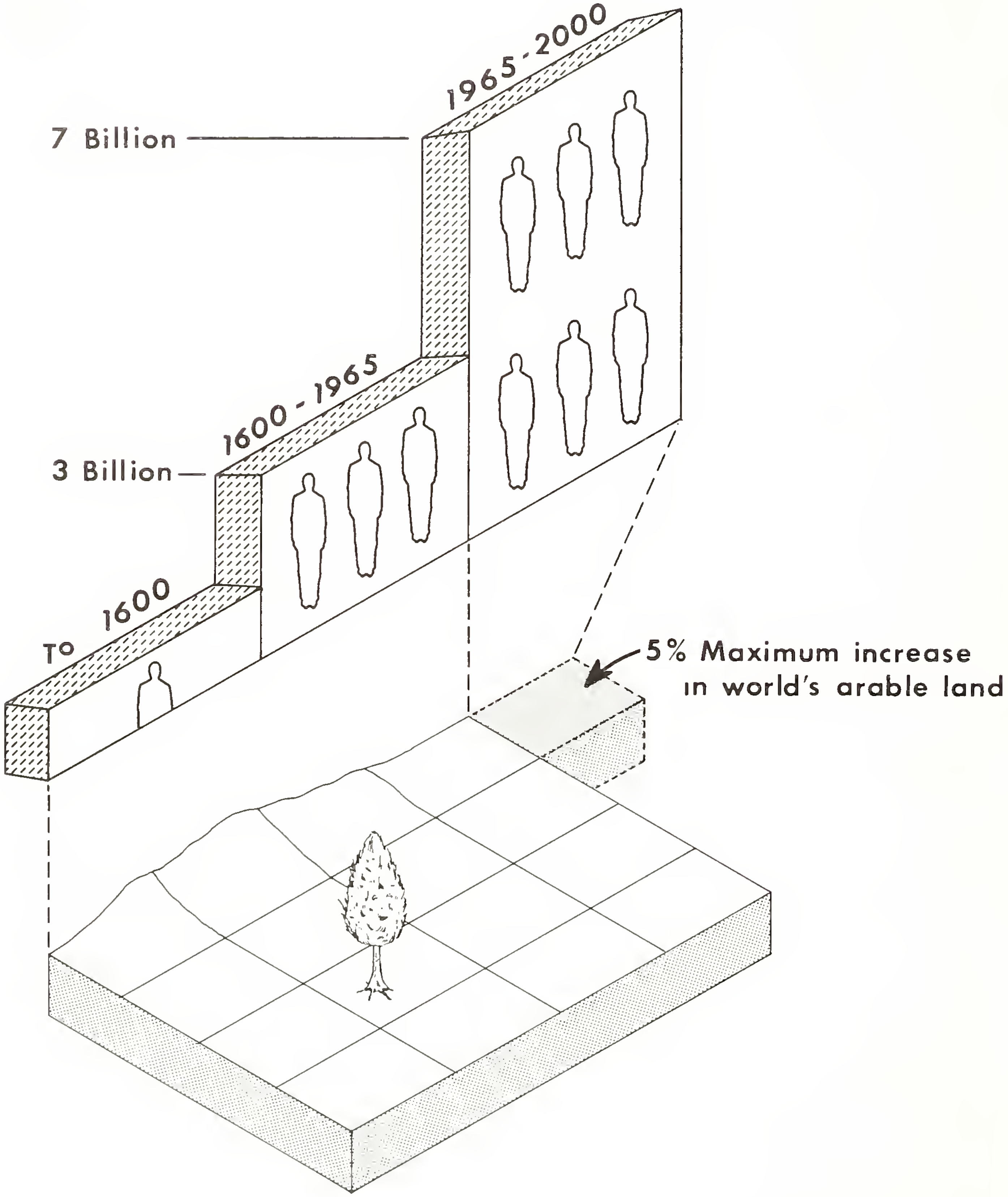

Figure 2.—ARABLE LAND, A RELATIVELY INELASTIC FACTOR.

functional properties of significant breadth. As a result, there is actually no ideal protein ingredient on the market today which has both wide function uses and exceptional nutritional advantage. That is, of course, other than the conventional proteinaceous foods which are not, for the purpose of this brief talk, considered as protein ingredients.

In addition to functionality and nutrition, the ideal protein ingredient should be capable of being produced ·anywhere in the world. The present protein ingredients suffer in this regard in that the common oilseeds cannot be grown in many areas. Since caseinate requires excess milk production, it strongly relies on the economic level of the country involved. Thus, the oilseeds and milk proteins must be produced locally or imported. One or the other is, in some cases, impossible or too expensive.

One of the most intriguing new protein ingredients rapidly coming on the scene is Single Cell Protein (SCP).

First, I'd like to try to define the term "Single Cell Protein." It is actually a misnomer since all protein originates from single cells. At any rate, it refers to protein derived from bacterial or yeast cells grown under controlled conditions. Much of the lay publicity talks about Single Cell Protein grown on petroleum and so the term Protein from Petroleum is often heard.

Actually, bacterial or yeast fermentations from which SCP are derived may use one of several energy sources including:

- cellulose
- molasses
- sulfite wastes
- purified hydrocarbons
- other petroleum derivatives
- and many others, in addition, of course, to a nitrogen source and other nutrients.

The petroleum and petroleum derivatives explain the preponderance of oil companies involved in this effort. In any event, the typical process involves the continuous growth of a chosen organism in a fermenter. Cells are continuously siphoned off, treated in various ways, sterilized, and dried.

An interesting analogy may be drawn with either cattle or plant production. Do we not choose the most efficient strains of cattle for instance, feed them various sources of energy plus urea, antibiotics, molasses, and such. At certain weights, they are slaughtered—or siphoned, shall we say—processed, sterilized for canned distribution or dried occasionally, and prepared for food. Well, we know the composition of beef. What then is the composition of Single Cell Protein? This depends to a large degree on the medium used, on the organism grown, on the process conditions, and many other variables.

Generally, the total dried intact cell will contain from 50 to 80 percent protein, small quantities of ash, fat, carbohydrates, and varying amounts of nucleic acids. This leads us to the next question— "What should Single Cell Protein, or SCP, exhibit to earn a share of the future protein ingredient market?"

Nutritionally, SCP should exhibit properties at least equivalent to the best competitive proteins. We're now talking about casein and its Protein Efficiency Ratio, its digestibility and its biological value.

Functionally, and this is most important, for if SCP were the best nutritional protein on the market but acted inertly like sand in food, its use would be fatally limited. So, certain major functinal properties must be inherent in SCP, or like the soy products, built into the materials in order to compete effectively on the market.

With regard to functionality, certainly the major segments to target for are the baked goods, meat, beverages, and snack markets. To do so, however, solubility, moisture and fat retention, blandness and whiteness, among other proterties, are important. To achieve such functionality, a very broad knowledge of the food technology involved is required and close cooperation among the food research, process engineer, and technical marketing people is necessary.

What are the projected requirements for the ultimate protein over the presently available protein ingredient sources?

We feel the potential lies with:

- the high protein content (50 to 80 percent): perhaps an isolate of 95 percent protein,
- the possible high nutritive value—depending of several factors,
- positive organoleptic characteristics—bland and white,
- the fact that the main substrate sources are abundant industrial byproducts,
- that production is independent of climate, pestilence, pesticide residues, etc.,
- that the cost per lb. of protein is expected to be competitive,
- that tight control of variables of production is possible,
- and that the potential for improving costs and nutritive value is good.

Assuming that SCP producers are successful in developing products that exhibit competitive nutritive value and functionality, we must then decide at what price level the material can be sold. Obviously, this price level must also be competitive. If, however, significantly superior products were developed which were equal to casein, nutrition-wise, and to the soy products functionality-wise and with no off-flavor—the price would naturally rely on the demand. This dream product is the goal of the entire protein suppliers' market and the SCP people are setting their sights on it too.

Finally, it should be made very clear that although there are problems with the existing protein products in terms of flavor, functionality, and nutrition, they fulfill a very definite need. They—and I refer to the milk and soybean protein derivatives—are performing an excellent service nutritionally while providing the food industry with a reasonable ingredient alternative for functional usage. There is no question that these products will survive as the need for protein increases in the world. There is also no question that as the scientist improves and improvises, such products as cottonseed, fish, peanut, and Single Cell Protein ingredients will find their place in this rapicly expanding market. It cannot be stressed enough, however, that the nutritional contribution of these products is not enough; they must exhibit functional advantages to the food processor if their share of this dynamic market is to be truly significant and profitable.

GUIDES TO SUCCESSFUL MARKETING

by

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Fayetteville and the University are some distance from New Orleans but still within the influence of the Southern Utilization Research and Development Division. I feel it is important that technical research devoted to utilization be concerned with marketing. In the laboratory known as the "market place" the ultimate test for any product is the vote of the consumer.

In keeping with the title of this presentation, I wish to focus your attention on the meaning of marketing. We need to clearly distinguish between selling and marketing.

The major thrust of *selling* is the interest and concern of the seller. The seller's primary objective is to convert his product into cash.

Marketing focuses upon the interests and concerns of the consumer. The primary objective of marketing is to satisfy the needs of the consumer. Satisfaction or lack of satisfaction results from the entire complex of services associated with preparation, delivery, and consumption of a product.

In addition, I would like to emphasize the need for a long run view of marketing. Successful marketing is dependent upon repeat sales. In this context, our preoccupation with profitable distribution of current commodity is false. Most production processes require large fixed investments that will require many years with repeat sales to repay. This emphasis is in keeping with Dr. Efferson's remarks this morning that the next year or two are already fixed based upon previous planning and we should turn our attention to what will happen 3 to 8 years from now.

For this conference I think it would be well for us to keep our remarks more general in considering guides to successful marketing. If the consumer is as important as we imply, her role should be perhaps our first consideration. We must be acutely aware of changing life styles. This applies not only to the product but also to the packaging, the size, the degree of preparation, the method of processing, and all the other aspects of the final consumer product. Production processes can influence our expenditures for the basic requirements of life—food, shelter, and clothing. There is need for firsthand information by all persons and firms associated with the product from its raw unproduced state to the final consumer product. We cannot afford the luxury of producer ignorance regarding consumer satisfaction. The total marketing system must do a better job of transmitting meaningful signals from consumer to producer and vice versa regarding quantity, quality, form, time, place, and price. If firms responsible for the functions of marketing do not perform this satisfactorily, emerging firms will and existing systems will become obsolete. Dr. Senti expressed disappointment that people did not always eat what was good for them; this tends to emphasize our need to concentrate on what is acceptable by the consumer.

There is a real need for keeping up-to-date in our marketing system. Rapid technological developments set the stage for rapid technological obsolescence. New proven technology must be adopted at all levels of marketing and by all firms providing the many varied marketing functions. Most consumer products today can be procured from more than one source or producing areas. Area competition exists and the area that does not keep current will lose out.

We must also keep abreast of substitutes and synthetics. These now take a share of the market equal to 10 percent of the market value of agricultural products.

General suggestions that are applicable to the domestic market are equally applicable to the foreign market because it is no different in this respect than the domestic market.

Another important consideration is the impact of social technology upon marketing and the market structure. Students of marketing have for years pointed out the advantages and advocated the standardization of products, the uniformity of flow, and the adaptation to market needs. In a society of 200+ million people the needs are consistent—they are not here today and gone tomorrow. Markets in terms of the consumer purchases may appear to be highly variable because of the techniques we use to satisfy the consumer, we are too concerned with selling—getting rid of our present supply regardless of quality. Changing life styles demand prepared, convenience foods. These require standardized products. Frozen dinners, for example, require uniform size of vegetables, meat cuts, and other items that go into a package that is sold on the basis of weight.

Vertical management coordination is capitalizing upon the economics of this knowledge. Vertical management means the centralization of management decisions. Producers are willing to permit certain decisions to be made by centralized management for the assurance of a market—quantity and price for a product. This organizational technique enables each unit of the production and marketing process to concentrate upon the art and science of its job.

We may ask, "What is the role of the entrepreneur in vertical management coordination?" The answer is threefold. It is to facilitate the flow of product from its raw unprocessed stage to placing it in the hands of the consumer. It is to determine the needs of the consumer and make arrangements for satisfying these needs. And, finally, it is the coordination of all phases of the production and marketing process.

The initiator of management coordination can originate at any stage in the production-marketing chain. Economic advantages will stimulate its adoption. The initial role of the initiator is not necessarily the key to its success. Producers could assume this role if they are willing to make the effort. It will probably be accomplished by the unit that has the most to gain and assumes sufficient drive to accomplish the objective.

In summary, let me emphasize four points. Marketing means determining the needs of the consumer and designing products to satisfy those needs in terms of time, place, and form. Successful marketing will necessitate concentrating upon changing life styles and adjusting our products and our processes and structures to meet these changes.

Adjustments in our marketing structure can well mean as much emphasis upon modernizing the decision making unit—management—as upon modernizing the physical facilities. And finally, we are going to have to cultivate our foreign market in the same way we have developed our domestic market.

SUMMATION

by

J. A. Whatley

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Dr. Meenen handled my job of summing up the discussions in this conference very well. He did an excellent job of bringing out some important points that have been discussed in the conference and I don't think I could improve on his remarks.

Throughout the conference, it has been evident to me that competition is one of the most important factors involved in the procedures by which we obtain an increased use of southern food crops. Mr. Wilkerson emphasized this very clearly when he indicated that there is need for quality products at a competitive price. Many others throughout the conference have expressed this same idea in other ways. It is, therefore, necessary to consider production practices; relate production activities to utilization research so that the best cultural practices, the best breeding of desirable varieties for processing, and such are involved in producing quality products at this competitive price.

In the course of the meeting, many examples have been given for developing of new products by research workers both in public institutions and private industry. It is very important that this effort be continued to expand our markets for food products in the South. You who are engaged in this program are to be congratulated. Public institutions and private industry need to continue to work together in this very important aspect of expanding demand for southern food products.

We have covered a very wide range of topics relating to marketing and we have concluded the conference with a very excellent panel on marketing. We discussed pollution—but we didn't really get into the nitty gritty of this—we were polite to one another here, but I am sure that will change in the months and years ahead.

We have discussed the matter of pests and pesticides, sanitation, food processing, and production relating to processing needs.

Dr. Senti did an excellent job in opening the conference and indicating that we can improve the nutrient composition of foods in three ways. His discussion of these three ways laid the groundwork for many variations of these methods throughout the conference.

Dean Efferson reported in an excellent manner on the export potential for southern crops. He presented a picture of continued expanding world population and indicated that the "green revolution" is not going to solve world food problems and that the "green revloution's" effect has probably been overestimated. I certainly agree with him on this. He predicted enough expansion in food production in the next 5 years to prevent a major famine, but no indication of excessive surpluses either. I think this is rather encouraging and the fact that we may expect large exports to continue in the next 5 years. But, there will be greater competition and lower prices in the world market. He then gave us a very good picture of the world outlook of various commodities.

I would like to express the appreciation of all of us to the program committee for developing this very excellent program. We certainly appreciate the fine work of Dr. Fisher and his staff, and particularly, to Dr. Wojcik. He was co-chairman of the program committee which planned an excellent program.

In closing I want to thank all of the session chairmen and all of you who have participated on the program and those of you who have been such an excellent audience.

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